THE

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THE

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THE LIVERPOOL OVERHEAD RAILWAY AND DOCKS.

A TIMELY article in *Cassier's*, by Mr. S. B. Cottrell, of the Liverpool Overhead Railway, will be welcome to those who hold that there is no necessity to go to America for electrical railway plant. Everyone seems to have forgotten the excellent working of this line.

The bulk of Mr. Cottrell's article is descriptive and general; but we may, at the risk of repetition, give again the salient figures of the motive power. The trains originally consisted usually of two 45 feet double bogie cars; the bogies, at 32 feet centres, have each four 33-inch wheels. Each car carries 58 passengers, first and second class. There are now three cars to a train. The motor armatures are series wound and ungeared, being direct on the axles of the cars, no special locomotive being used. Each motor gives 1,790 lbs. traction with 120 amperes, or 107 lbs. per ton of train.

A fully loaded train of three coaches weighs 57 tons, of which 9 tons 10½ cwt. is due to the motor equipment. There were originally six 30 feet × 8 feet Lancashire boilers and four horizontal compound 400 I.H.P. engines, each driving a dynamo of 500 amperes × 400 volts. The combined efficiency is 85 per cent. at full load. The additions since starting have been two more condensing engines of surface condensing type, and also of 400 I.H.P. each, at 100 revolutions, with 120 lbs. boiler pressure. The fly-wheels are 14 feet diameter, grooved for 19 1¼-inch ropes.

As usual with rope-driven dynamos, we observe that the dynamo pulley is placed lower than the top of the fly-wheel, so that the ropes, as they travel to the dynamo, are always tending to throw off the face of the pulley. This is wrong practice. Sudden changes of load are apt to cause the ropes to leap in a huge hump and slip badly on the dynamo pulley. A dynamo pulley top ought to be higher than the top of the driving pulley, so that the rope, running towards the dynamo, tends to run under the driven pulley, to encircle as much of the pulley rim as possible, and so prevent the humping which occurs on change of load. Rope driving is condemned by many electrical engineers. We cannot call to mind any place, unless it be at the large Deptford station, where proper considerations of the dynamics of rope driving have been allowed to influence design. Dynamos are almost always placed so that the ropes run down hill to the driven pulley. This is never done in factory driving, and rope driving is successful there, but the lowest set of ropes is often but little removed from the wrong placing, and the slack sides of this set of ropes is often noticeable as running so much less steadily than the up-running ropes.

The later dynamos at Liverpool are 500 amperes × 500 volts each, and they weigh each 24½ tons. About 80 acres of surface have to be painted every two years. By pneumatic process the cost of this painting, including all materials, has been reduced from 2·25d. to 1·24d. per square

yard. The motors run 40,000 miles before repairs are required. They earn £200 in that time, and can be rewound for £25.

The importance of Liverpool is to be judged by the fact that it is equal to London in the value of its trade, and much exceeds London in bulk of trade, dealing in articles of less mass value. Liverpool is the biggest grain centre in Europe. It is also remarkable in that its docks extend in a continuous line along a river front for several miles, and it is the passenger traffic of this line of docks and accessories which is served by the electric line. The old 'bus route only carried 2½ million passengers annually; the electric line carries now nearly 9 millions. Yet it is certain Liverpool has not increased in either trade or population by a tithe of the increase of passengers.

In face of this remarkable fact, we have the management of the London Underground shivering on the brink of electrical enterprise, seeing their trade liable to slip away any day in dirt, gloom, and sulphur, yet afraid to make the plunge necessary to success. The success of the Liverpool line ought to be sufficient to show how traffic may wait for facilities and expands as soon as facilities are afforded. Of course, there is no comparison between the convenience of the electrical line and of the old 'bus line which used the rails of the dock railway, but the old 'bus line was practically the only means of travel along the line of docks, and might have been argued to take all possible traffic. Given the facilities for more convenient travel, and the travel has at once sprung up. It is simply by acting on this principle that America owns its thousands of miles of electrical railway, while there are so few in England, even with so good an example as Liverpool for encouragement.

Weatherproof Wire.

In his interesting letter published in our last issue, Mr. Dow has unfortunately misunderstood the first of our questions, "How is it possible to maintain such circuits in wet weather?" Our query did not refer to the maintenance of a high insulation resistance, which we consider, in agreement with Mr. Dow, is quite unnecessary for the working of the line so long as the leakage is uniformly distributed and is not due to one or two weak places; but did refer to its maintenance in good repair. The question was asked, because in one part of the paper on which we were commenting, Mr. Dow stated that the first rainy days of autumn might always be expected to produce a fair crop of burn-outs and earths, and in another part he stated that work bringing the linesmen into proximity with the wires should never be attempted during bad weather; and it appeared to us difficult to understand how the line was to be maintained in good working condition, and a good service given, if repairs were not to be attempted without stopping down all the circuits.

Testing an Enormous Electric Beacon.

Some interesting tests are now being made at the general depôt of the United States lighthouse establishment at Tompkinsville, Staten Island, upon a gigantic electric beacon known as the Lepante bivalve or lightning lens light. We are indebted to the *Electrical World* (N.Y.) for some interesting details respecting this installation. The lantern consists of two lenses, each 9 feet in diameter, enclosing between them an electric arc of great power. In the central portion of each lens is a disc having two prismatic rings. Outside of this are 190 prismatic segments so arranged that the light of the arc is totally reflected in each and thrown out in a beam practically non-divergent. In this way nearly the total light of the arc is concentrated in two great beams, 9 feet in diameter, directed toward opposite points on the horizon. The whole apparatus is floated on mercury, and is driven by a powerful clockwork actuated by a spring. The period of revolution is once in 10 seconds, so that every point on the horizon receives a flash from the lens in each 5 seconds, these flashes being of about $\frac{1}{12}$th of a second duration. The lamp, lenses, and supporting framework weigh about 20 tons, and the friction is so reduced by the use of the mercury float that the whole apparatus can be easily turned by the pressure of one finger. The arc lamps, of which the lens contains two, one at its focus and the other arranged to be brought into play immediately upon the failure of the first, are of a curiously complicated structure, and yet very simple in principle. The arc is struck by hand. The two carbon holders are connected together by means of a chain actuated by clockwork, the last wheel being a detent, in which is engaged a small pawl, operated by an electromagnet in shunt around the arc. When the arc lengthens out and its resistance increases, this coil pulls away the detent and permits the clockwork to feed the carbons together. The lamps are of the most elaborate construction and finish, but it cannot be said that the complexity commends itself to the engineering sense. Both lamp and lens were made by Henri Lepaute, Paris, and the whole outfit was exhibited at the World's Fair, and subsequently at Atlanta and Nashville. It was purchased by the United States Government, but its location has not yet been determined upon, though it will likely be installed at some point along the Atlantic coast, if the tests now in progress are satisfactory. There is every indication that they will fulfill every condition imposed upon the apparatus. The lamps are arranged to carry carbons of from 15 to 60 millimetres ($\frac{5}{8}$th to 2½ inches) in diameter, and the current consumption varies, of course, with the size of the carbon. The original apparatus was provided with an alternating current generator of French make, but it has been decided to use with the lens an alternating generator made by the General Electric Company, driven by a 25 H.P. Ideal engine, which takes its steam from a 25 H.P. Fitzgibbons boiler. The present tests are being conducted with current taken from the local lighting service, the frequency being 140 cycles per second, and the consumption with 30-millimetre carbons being about 60 amperes at 55 volts. It is estimated that the horizontal candle-power of this arc without the lenses is not less than 9,000. Mr. C. A. Lamy, superintendent of the lighthouse depôt at Tompkinsville, estimates that the total candle-power of the two beams of light is not less than 90,000,000. He arrives at this figure by adding together the candle-powers of the various beams emerging from the prismatic part of the apparatus and the lenses. The beam is of enormous power, and will be easily visible at a distance of 100 miles, if mounted in a sufficiently high tower. The light can be located even when mounted in towers of ordinary height at a greater distance than this, on account of the reflection from the clouds of the strong beams. When the lantern is installed in service the electric generating plant will be in duplicate throughout, to avoid any possibility of an accident. It is curious to note that the constructors of this apparatus seem to prefer clockwork for its rotation. With the alternating current supplied for the arc, there seems to be no reason whatever why the rotation of the lens should not be accomplished by means of an alternating motor, a far simpler and more reliable device than the elaborate and complicated clockwork now connected with it. The lens was set up, and the tests are now being conducted, under the supervision of Lieut.-Col. D. P. Heap, Corps of Engineers, U.S.A., Engineer of the Third Lighthouse District, who is ably assisted by Mr. Lamy, Assistant Superintendent.

THE UTILISATION OF BLAST FURNACE GASES FOR ELECTRICAL POWER TRANSMISSION.

By W. H. BOOTH.

A reference appeared in these columns some little time ago to the tests made by the writer upon the electric light plant laid down at the Wishaw Iron Works of the Glasgow Steel and Iron Company for the purpose of proving the value of the Thwaite-Gardner system of utilising the waste gases from blast furnaces for producing power. At Wishaw the power generated is distributed over the works for the purpose of lighting up the furnaces, the residuals plant and the offices, arc and incandescent lamps being used. The gases which leave a blast furnace do so at a comparatively low temperature, usually not far from 500° F., more or less, or not so hot as the waste gases from many boiler furnaces. Possibly it is because of this, and because the waste gases are partially employed to heat the hot blast, that it is so often claimed that the blast furnace is an economical "machine." True as regards the total heat generated, which may be considered as represented by the maximum temperature at the zone of fusion, the proportion of heat utilised may seem great, but in stating this the true facts are ignored. There are only three products from a blast furnace. One of these, at present considered the primary product, is iron. This is run from the furnace at a temperature of, say, 2,800° F. As the specific heat of iron is only about 0·113, or, say, one-ninth that of water, the heat carried away by a ton of iron is only equivalent to that carried off by a ton of water at about 311° F. Assuming 25 cwt. of fuel at a calorific value of 15,000 B.T.U. per pound, the heat waste per ton of pig is only represented by about 46 lbs. of fuel, or 1½ per cent. of the total fuel.

A further amount of nearly 3 per cent. of the fuel disappears in the 80 lbs. of carbon which enters into combination with the iron. Probably another 3 per cent. disappears in the slag, which is also run out at a high temperature, and, if worth the expense of apparatus, could be made to give back this heat in heating the blast. Altogether about 7½ per cent. of the fuel energy appears at the tapping holes, and certain other heat disappears in chemical changes, in setting free CO_2 from its combination with the ore or flux. Then probably there are 15,000 lb. of gases per ton of iron with a specific heat of 0·25 at 500°. This represents the heat of 125 lbs. of fuel, or about 4½ per cent. of the fuel. This heat is more or less recoverable in heating the blast. It is thus perfectly clear that the waste gases must contain

Table I.

	Blast furnace gas.		A gas producer.
	Wishaw.	Frodingham.	
Carbonic acid	5·75	6·0	6·6
Carbonic oxide	24·75	27·3	19·6
Hydrogen	2·33	1·5	6·4
Marsh gas	0·75	...	1·3
Nitrogen	66·42	65·2	66·1
	100·0	100·0	100·0
Heat units per cubic foot ...	97·8	96·7	98·0
Calculated cubic feet per I.H.P.	79·44	80·34	79·27
Percentage combustible ...	27·83	28·8	27·3

not much less than 88 per cent. of the total heat capacity of the fuel. As this is not visible as temperature, it must be visible in some other form, and it is so visible as the calorific capacity of carbon monoxide, of which gas the effluent gases of a blast furnace contain about 28 per cent.

In two samples of gas, No. 1 from Wishaw where, as usual in Scotch furnaces, coal is the fuel employed, and No. 2 from Frodingham, where coke will be used and where a Thwaite plant is also at work, these percentages are seen to hold good.

Blast furnace gas is thus fully equal to gas from a producer. A producer is recognised as yielding a gas capable of working in a gas engine. Yet the blast furnace gas of equal quality has required considerable demonstration to convince people of what an analysis ought to have been sufficient to indicate to them.

Approximately about three-tenths to one-third of the waste gases are combustible, the remainder being diluents, and calculated on this basis from the analysis of the gas, a full half of the original calorific value of the fuel remains, apart from the sensible heat, the difference between the 50 or 60 per cent. remaining, and the above 88 per cent. being accounted for in the latent heat absorption of the wet materials and the gasefying of locked up CO_2 of the ore and flux as well as in loss by radiation and connection through the furnace walls, and by a margin of safety.

If we base our calculations on the low assumption of one-half the fuel being available for power, and we know that a liberal allowance for a horse-power-hour in a gas engine is 1 lb. of fuel, we may calculate the horse-power of a blast furnace as being 1,120 H.P. per ton of fuel used per hour, or 1 H.P.-hour per 2 lbs. of fuel, of which 1 lb. is given over to the purposes of the furnace and 1 lb. remains for power purposes. These figures which are calculated on liberal assumptions are more than borne out in practice. At the time of the writer's tests, the furnaces were delivering a poor quality of gas, yet on the assumption of only 180,000 cubic feet per ton of fuel fed to the furnaces, the measurement of the current generated by the dynamo, and of the gas drawn from the holder meter in runs of five minutes, only showed a fuel consumption of 1·656 lbs. per electrical horse-power, which is to say, that for each 1·656 lbs. of fuel used one horse-power of electrical energy could be delivered at the dynamo terminals. If, as seemed probable, the furnaces were producing 200,000 cubic feet of gas per ton of fuel, the fuel per electrical horse-power would only be 1·49 lb. or with an efficiency of 75 per cent. between terminals and cylinder, about 1·12 lb. per I.H.P. The works manager obtained better results than these, but not more than would be accounted for by known variations in the quality of the gas, which may vary its proportion of constituent combustible between 28 and 38 per cent. As there is considerable divergence among different authorities as to the number of cubic feet of gases produced for each ton of fuel consumed, I have prepared Table II. for the purpose of showing in the particular analysis given of the gas at Wishaw how much is really produced, observing that this particular analysis is of a more than ordinary poor gas, the volume of diluent nitrogen being very great—over 66 per cent. of the volume.

From this table it appears that 100 cubic feet of gas weighs close upon 8 lbs., so that the average specific gravity in pounds per cubic foot is 0·079 as might be expected from the large percentage of nitrogen and of carbonic oxide, both which have the same specific weight of 0·0784. The heavier carbon dioxide brings up the average slightly.

From the table it appears that of the total weight of gas, 1·0503 consist of carbon, the bulk of which is derived from the fuel: it is evident that 1 lb. of carbon represents, therefore, 7·525 lbs. of gases. An ordinary blast furnace practice allows 12 cwt. of limestone flux to each 20 cwt. of coke. Basing some further figures on this ratio, 6 : 10, we may, for a coke furnace, make the following equation :—

$$\begin{aligned} \text{Carbon in 10 cwt. of coke} &= 10 &&= 10 \\ \text{,, 6 ,, flux} &= 6 \times \frac{C}{Ca\,CO_3} &&= 0{\cdot}72 \\ \text{Total} & & &\overline{10{\cdot}72} \end{aligned}$$

The fuel carbon thus represents $\frac{10}{10{\cdot}72} = 98$ per cent. of the whole, and we may, therefore, say that each pound of carbon in the fuel will represent 98 cubic feet of gas, so that one ton of fuel will yield 217,000 feet of gas.

These figures are not absolute for the particular analysis, because it cannot be accurately known how much of the hydrogen of the bituminous coal used in this furnace, as usual in Scotch practice, is converted into steam and cannot appear in an analysis of permanent gases, but they are sufficient to indicate that the figure of 180,000 feet per ton

of fuel will not be far wrong for a coal burning furnace when using a less amount of air. From 80 to 100 feet of gas may be therefore assumed correct per pound of fuel used, and as it is very easy to test the volume of gas consumed by an engine, the power output per pound of fuel is readily found.

The calculations of Table I. are of course based on the customary temperature of 0° Centigrade. Any test figures as to consumption of gas by an engine will show 10 to 12 per cent. more consumption than if measured at the base temperature, the gas in the holder during my own tests being about 550° F. absolute temperature. It need not really concern us how much heat disappears in volatilising the carbonic acid and oxygen locked up as solids in the flux and in the ore. The only items required are the total carbon which enters the furnace and the weight of carbon in the gases. Knowing these two quantities it is easy to calculate the amount of combustible gas produced by a ton of fuel so long as we have the proportions of CO and CO_2 into which the carbon is more or less oxidised. The complicated conversions and reconversions, and general chemical reactions between the tuyeres and the furnace top need not concern us at all. It is of course a point with metallurgists to obtain as much CO_2 as possible as an indication of fuel economy, but Lowthian Bell has shown there is a limit below which the ratio of CO must not fall, and, with power an important product, the straining after a high percentage of CO_2 would be unnecessary and undesirable. The power system thus frees the blast furnace management of considerable anxiety, rendering fuel waste impossible—indeed, desirable as furnishing a better gas, for with all the gas used as power, there would be no object in making any more carbon dioxide than could possibly be helped. The estimate of 1 horse-power from each 2 lbs. of fuel is thus well within the mark.

(*To be continued.*)

Table II.

Gas.	Per cent. Volumes.	Weight per cubic foot.	Weight per 100 cubic feet of mixed gas.	Ratio of constituents.	Actual weights of elements per 100 cubic feet of gas.			
					C.	O.	H.	N.
Carbonic oxide = CO	24·75	0·0784	1·9404	3 : 4	0·8316	1·1088	...	...
Hydrogen = H	2·33	0·0056	0·0130	...	...	...	0·0130	...
Marsh gas = CH_4	0·75	0·0448	0·0336	3 : 1	0·0252	...	0·0084	...
Nitrogen = N	66·42	0·0784	5·2073	...	...	...	...	5·2073
Carbonic acid = CO_2	5·75	0·1234	0·7095	3 : 8	0·1935	0·5160	...	...
Cubic feet =	100·00	0·079038	7·9038	Total	1·0503	1·6248	0·0214	5·2073
					7·9038			

"FREE" AND "EASY" PAYMENT SYSTEMS OF HOUSE WIRING.

By V. ZINGLER, A.I.E.E.

The above title must not be taken literally, or as the heading of a scheme whereby it is sought to show that the debtor of a wiring company is under no further moral obligation to pay his bill to them than he is to his tailor; it is merely a summary of the names of two systems, whereby the distribution of the electric light is to be made more universal, to the mutual advantage of the public and the wiring firms or electric light companies, the corporations being after all the public also.

With the free wiring system—improperly so called—we are all more or less familiar, although there are points in connection with its application which have no doubt not been fully considered. But with the easy payment system the public has not been made familiar, for the simple reason that no financial or wiring firm would be able to get their shareholders to put their money into a concern which would have to spend any amount of money with only the chance of getting a small interest in return, and on no further security than that of the consumer's word, with the alternative of a lot of installations thrown back on their hands, only partly paid for, and situated in property belonging to other parties.

If, however, some solid security for the payment of this class of work could be obtained, the matter would have a different aspect; and in a recent report to the Electricity Committee of the Plymouth Corporation, Mr. John H. Rider, the borough electrical engineer, sets forth a scheme of some boldness, with which it is our intention to deal in comparison with the alternative scheme of the National Electric Free Wiring Company.

After reciting some of the aims and methods of the scheme now in use by the latter company, Mr. Rider proceeds to point out that the system of paying an extra sum per unit—this excess being interest on the capital sunk in the house-wiring, &c.—is very unfair to the consumer, because the percentage will rise as the price per unit is reduced. That is to say, at 8d. per unit an extra charge of 1d. is 12½ per cent., whereas at 4d. it would be 25 per cent. He also points out that under this system the more electricity is used the more the customer has to pay for fittings, and he classes this as unfair also. But is not this itself an unfair way of looking at the matter? It may be assumed that the average consumer will use about as much electricity whether he pays 4d. or 8d. per unit for it—that is to say, the class of consumer for whom the schemes cater. He has a fixed number of lamps in his villa, or shop, and he uses just those lights which he wants. Therefore, he is not likely to use much more electricity at the lower rate than he uses at the higher rate; and as there is nothing to prevent a supply company from putting down its rate per unit, any proportional reduction of the excess for wiring would mean a diminution of income to the wiring company unless it could be proved that the consumption of electricity increases in inverse proportion to the rate per unit.

As regards the amount of electricity that a consumer uses, is it certainly not fairer that he should pay in a certain proportion to the actual use he gets out of the wiring and fittings rather than for the length of time these goods are in his house? If a man hires a piano, he has to pay an exorbitant interest on the value of the same, irrespective of the fact that he may hardly use it at all; whereas, if he had to pay a certain rate for the number of horse-power-hours which he put into the piano, or in default of not using it at all, a certain minimum sum representing the value of depreciation plus a moderate interest, it would be much fairer to all concerned. This is the method which the Free Wiring Company have adopted. The Board of Trade units used are proportional to the amount of benefit that the consumer gets out of his wiring and fittings, and there is no reason why he should not pay for it at an equal rate, no matter what the cost per unit of electricity, as the two things are perfectly distinct. It may, on the other hand, be urged that just as it is found profitable to give the customer a rebate on the cost of electricity after a certain consumption per diem, so it would most likely also be advantageous to all parties concerned to give him a similar rebate on the excess sum per unit for wiring and fittings, the point at which this rebate should come into operation being determined by the sum representing fair interest of capital sunk required from him.

Proceeding, Mr. Rider says that the average consumption is about 18 units per 8 C.P. lamp per annum, and he there-

fore complains that an excess charge of 1d. per unit for fittings, &c., is equivalent to 7½ per cent. per annum, assuming that the cost of fitting up a house comes to £1 per lamp. Now it is a fair question to ask Mr. Rider whether he approves of wiring and fittings being put up for this price, even for a large installation. As a borough engineer, he will know that good work cannot be done for this price; how much less then will it be possible to instal, say, 10 to 20 lights, the size of installation catered for by this system, for £1 per light, including main switch, fuseboard, and making good. Even assuming 7½ per cent. as being the interest paid, is it excessive, when considering that the installation is guaranteed for six months, that the consumer has no liability as to the time he shall use the installation for, and that the company has to take the risk in this 7½ per cent. of fire, default, and depreciation of a neighbourhood, in which cases they are put to the expense of loss of interest or capital, or of taking down the fittings.

The report then goes on to suggest a scheme for spreading the payment over a long time so as to avoid the heavy initial cost; such a scheme could not be operated by private wiring firms, as we all know that in these days of keen competition they are more anxious to receive long credit than to give it. Mr. Rider also points out that this might be done by the Corporation, but that experience has proved that it is unwise for Corporations to undertake wiring work. This is certainly the result of the experiment at Liverpool, where the monopoly held by the Corporation for wiring became so intolerable that there was not—up to a year or two ago—a single good wiring firm in the town. The Corporation looked with jealous eyes on any wiring work obtained by outside firms, and the latter had no cause to complain that the Electricity Department did not enforce their regulations. However, this is a digression.

Mr. Rider's scheme now begins to develop itself in detail. He argues: Wiring firms can wire but not give credit; Corporations must not wire but can give credit; *ergo*, let the wiring contractor do the work, and the Corporation give the credit!

Let us give the scheme in his own words:—

"The wiring contractor would canvass for orders in the usual way, and could carry out work for any customer on his own terms without reference to the Corporation. But when a person wished to avail himself of the easy payment system, he would have to proceed in the following manner.

The quotation to such customer would be made out upon a special form, binding the contractor to carry out the work to the satisfaction and under the supervision of the Corporation, and naming such a price for the work as would permit him to allow a discount of 5 per cent. for cash.

If the customer agreed to this price, he and the contractor would notify the acceptance in writing upon a form of application to the Corporation. This form would set forth the terms of the proposed agreement, which would be somewhat on the following lines, viz.:—

(*a*) That the contractor will carry out the work in accordance with the conditions, regulations, and other requirements of the Corporation, and to the entire satisfaction of the borough electrical engineer.

(*b*) That the contractor will allow to the Corporation a discount of 5 per cent. from the quoted price, for payment within one month of the date of the work being completed and connected to the mains.

(*c*) That the customer will pay to the Corporation the quoted price in full by means of eight equal instalments, the first being sent with the application in the form of a deposit, and will pay a similar amount every three months from and after the completion of the work, until the whole be paid.

(*d*) That the work will remain the sole property of the Corporation, until the full amount be paid.

(*e*) That the customer will be responsible for any damage to the work (reasonable wear and tear excepted) while it remains the property of the Corporation.

(*f*) That all lamp and fuse renewals will be carried out by and at the cost of the customer.

(*g*) That in the event of a customer's payments being more than three months overdue, the supply of current will be liable to be cut off without notice, and proceedings taken for the recovery of the whole amount due.

(*h*) That (if required by the Corporation) the customer to provide two securities for his due fulfilment of the contract.

If the customer, contractor, and price appeared satisfactory to the Corporation, instructions would be given by the Corporation to the contractor to proceed with the work, and upon the proper completion of the same the Corporation would pay him the quoted sum, less 5 per cent."

(*To be continued.*)

A PORTABLE ELECTRIC RAILWAY.

The great success of electric street railways has given rise to many attempts to apply electric traction to portable or field railways. In the earlier attempts the style of construction that had been worked out for street railways was applied with little change to the field railways, no regard being paid to the special requirements in the latter case.

A system, which is designed to meet these special requirements, has recently been worked out at the Field Railway Works of Arthur Koppel. From a description of this system in the *Zeitschrift für Elektrotechnik*, February 13th, 1898, we give the following summary:—

As in other railways, the track consists of easily transportable rail frames, made up of two rails of the usual field railway profile 65 to 70 mm. in height, connected together by, say, five crossbars (fig. 1). The overhead conductor is

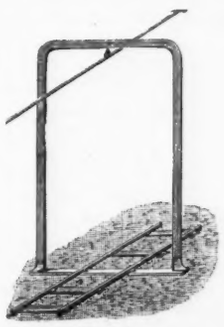


Fig. 1.

supported by a ∩-shaped yoke which is bolted to extensions of the middle crossbar of a rail frame. These yokes are placed about 25 m. apart along the track. The overhead conductor is supported at the middle of the upper horizontal part of the yoke. The weight of such a yoke is about 50 kg. more than that of the ordinary rail frame.

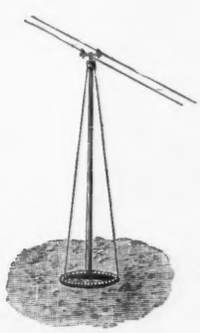


Fig. 2.

Fig. 3.

These yokes are placed closer together at curves, and at the sharpest curves it may be necessary to fit every rail frame with a yoke in order to keep the overhead conductor sufficiently near the centre of the track.

The generating station is fitted in the usual way with a dynamo which may be driven by a steam engine, gas engine, or turbine, according to circumstances. Two feeders are led from the station to one end of the track, one being connected

to the end of the overhead conductor and the other to the rails. The feeders are fitted with safety fuses. The feeders are supported on poles, which may be fixed or transportable, according to the nature of the line. In the former case they are driven into the ground; and, in the latter case, portable stands, fig. 2, with disc pedestals are used when the line is straight, and pointed poles with tension wires, fig. 3, at corners. Where one of the feeders is connected to the trolley wire, it is fastened to one of these anchored poles.

A special truck, fig. 4, has been devised for running the

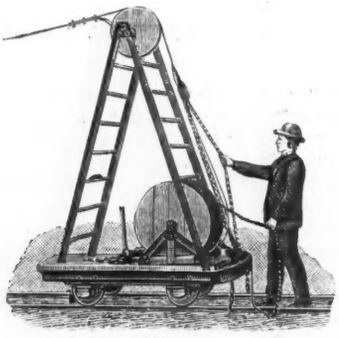


FIG. 4.

trolley wire. On this truck is fitted a reel containing the copper wire, and a pair of ladders supporting a guide pulley at the top. A sufficient length of copper wire is pulled off the reel, passed over the guide pulley and the free end is fastened to the end of the feeder connected to the anchored pole at the end of the track. The fitters' truck is anchored to the rails and the wire is stretched by a block and tackle and fastened to the insulator on the yoke. The truck is now moved along the track till another yoke is passed, when the same operation is repeated. The ladders, reel, and undercarriage of the fitters' truck is made of dry wood saturated with some insulating substance, so that current could not pass from the trolley wire through the truck to the rails.

This precaution is necessary because the end of the trolley wire is left attached to the truck when the position of the track is liable soon to be changed. When the track is to be permanent for a considerable time the end of the trolley wire is fixed to an anchored pole.

The solidly constructed motor car, fig. 5, has, as a rule, a

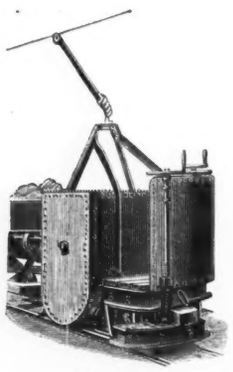


FIG. 5.

motor mounted on the frame of the undercarriage, and geared to the driving wheel axes by toothed gearing and two pitch chains. The frame of the undercarriage is furnished with spring bearings, spring buffers, and coupling arrangements. On the driver's platform is a brake and a switch handle. By means of the latter more or less resistance can be put into circuit, and the speed thereby varied within wide limits.

If the gauge of the rails is 500 mm. or more, the motors can be fixed inside the under-frame of the cars and be connected directly to the axes of the driving wheels by a spring coupling. This construction has the advantage of getting rid of the dead weight of a special motor locomotive, which is of great importance when steep gradients have to be ascended. The electric motor has the advantage over most other kinds of traction in the great range of its output.

These portable railways may be used with great advantage in connection with factories having spare steam power; or having an electric lighting installation. They may be employed for the transmission of goods during the day, and thereby furnish a useful day load to a lighting installation which otherwise would have occasionally to stand idle.

ALUMINIUM WIRES FOR OVERHEAD LINES.

By STUART A. RUSSELL.

THE paper on "Aluminium as a Rival of Copper and Brass for Electrical Conductors," reprinted in the ELECTRICAL REVIEW (March 11th and April 1st), details very ably all the points in which aluminium may show itself a formidable competitor of copper as an electrical conductor; and the author, Mr. A. E. Hunt, whilst allowing that for insulated conductors aluminium is heavily handicapped by the extra cost of insulation, claims that there is an ample field for the employment of aluminium wire for bare transmission lines, especially for high potential long distance work and for long distance telephone lines. Mr. Hunt quotes figures showing that as the weight of copper is three and a third times that of an equal volume of aluminium, and as the conductivity of the latter is 63 per cent. of that of pure copper (Matthiessen's standard), and further as aluminium wire is now offered for sale at a specially low rate, the prices of an aluminium and a copper wire of the same length and conductor resistance are equal. A comparison is then made between a soft copper wire having a tensile strength of 32,000 lbs. per square inch, and an aluminium wire having the same tensile strength per square inch and a conductivity of 63 per cent. of that of the copper wire, in which it is shown that for equal conductor resistance the sectional area, and therefore also the breaking strain of the aluminium wire will be 60 per cent. greater than that of the copper wire, whilst the weight of the former will only be 48 per cent. of that of the latter.

Mr. Hunt therefore concludes that the aluminium conductor could be used in much longer spans than the copper, and that the number of expensive poles and insulators could be materially diminished. It appears, however, that the effect of wind pressure on the larger aluminium wire has been altogether left out of account in coming to this conclusion, and the writer therefore proposes to give one or two examples to show how this statement must be modified when the effect of wind pressure is taken into account.

Let us assume a wind pressure of 20 lbs. per square foot, which is approximately the figure adopted by the Post Office, and that the ratio of the effective pressure on a cylindrical surface to that on a plane surface is 0·6, then the pressure, P, in pounds per foot run of wire will be numerically equal to the diameter in inches of the wire, and if W = the weight per foot run of wire, the resultant pressure, w, per foot run of wire = $\sqrt{W^2 + P^2}$. Taking as an example the copper wire ·100 inch diameter, and its equivalent in aluminium, of which particulars are quoted by Mr. Hunt, we find for the copper wire—

W = ·0304 lbs.
P = ·100 „
w = ·1045 „
t = safe working strain with a factor of safety of 4 = 63 lbs.,

and for the equivalent aluminium wire, which will be ·126 inch diameter—

W = ·0145 lbs.
P = ·126 „
w = ·1268 „
t = 100 „

To compare these two wires we may find the span, which will give the same dip, say, 5 feet for each, using the equation,

$$a = \sqrt{\frac{8\,d\,t}{w}};$$

from which we get a span of 155 feet for the copper wire, and of 162 feet for the aluminium one, which shows a slight difference in favour of aluminium. This will not, however, permit of any saving in poles, as the side strain on the poles due to wind pressure on the wires will actually be 25 per cent. greater with the aluminium than with the copper wires, and therefore heavier poles would have to be used.

In such small wires the effect of wind pressure is greater than with wires of larger sectional area, as the surface exposed to the wind does not increase so rapidly as the sectional area; and we shall, therefore, find a greater difference in the length of span if we take as an example a copper wire of ·300 inch diameter and compare it with its equivalent aluminium wire, the diameter of which will be ·378 inch. For the copper wire we have—

W	=	·2736 lb.
P	=	·300 „
w	=	·406 „
t	=	567 lbs.
a	=	236 feet,

whilst for the aluminium wire we have—

W	=	·1304 lb.
P	=	·378 „
w	=	·400 „
t	=	900 lbs.
a	=	300 feet.

The aluminium line would, therefore, need only four poles where the copper line would require five, but part of this advantage would be neutralised by the fact that, as the side strain on the poles due to wind pressure on the line would be 50 per cent. greater for the aluminium line than for the copper one, the poles for the former would have to be of larger diameter.

So far we have followed Mr. Hunt in comparing aluminium with soft copper, but if we compare the wires in the last example with an equivalent hard drawn copper wire of, say, 97 per cent. of the conductivity of the soft copper wire, and with a breaking strain of about 64,000 lbs. per square inch, we get the following figures:—

diameter	=	·305 inch
W	=	·2827 lb.
P	=	·305 „
w	=	·416 „
t	=	1,160 lbs.
a	=	334 feet,

showing that the advantage as to number of poles and also as to side strain on the poles lies with the hard drawn copper wire.

Mr. Hunt says in his paper that experiments are now being made with an alloy of aluminium having an increased breaking strain, and that although these experiments are not yet completed, it can safely be predicted that a wire of aluminium alloy can be furnished with a breaking strain per square inch equal to that of hard drawn copper, and a conductivity of not less than 50 per cent. of Matthiessen's standard. Such a wire would have a diameter about 40 per cent. greater than that of the hard drawn copper wire of equal conductor resistance, and if we suppose that its specific gravity and price per pound remains the same as for aluminium, it would cost from 10 to 15 per cent. more than the equivalent copper wire.

There is another point which should be taken into consideration, and that is, that the coefficient of expansion per degree rise of temperature is nearly 20 per cent. greater for aluminium than for copper, so that if the two wires are to have the same maximum dip in summer, the aluminium wire will have a smaller dip than the copper wire in winter, and will be subjected to a greater strain unless allowance has been made for this by taking a lower working tension in calculating the span from the maximum dip.

A SIMPLIFICATION OF THE MARCONI RECEIVER.

Dr. H. Rupp, of Stuttgart, has made an important simplification in the Marconi receiving apparatus, which he describes in the *Elektrotechnische Zeitschrift*, April 14th, p. 237. To restore the resistance of the coherer, Marconi, as is well known, employs an electric tapper, working like the hammer of an electric bell. This taps the coherer tube, loosens the filings and stops the current. This contrivance has been found to be somewhat uncertain in its action, and when a Morse instrument was used the dots and dashes were often not sufficiently separated.

Dr. Rupp dispenses altogether with the electric tapper in his arrangement, and decoheres the filings by causing the tube to rotate on its axis. The rotation of the tube is produced very simply by means of the paper ribbon of the Morse instrument. The leading-in wires of the coherer are mounted in bearings, and a small vulcanite pulley, with flanges, is fixed on one end of the tube. The tube is put in circuit by two small copper springs, which rub on the rotating axes. The paper strip of the Morse instrument passes round the pulley between the flanges.

Fig. 1 shows this coherer partly in section.

Fig. 1.

The paper spool of the Morse instrument is slightly braked by a brass spring, in order to produce a uniform tension on the paper ribbon, and thereby a uniform rotation in the coherer tube. The arrangement of such a receiving station is shown diagrammatically in fig. 2.

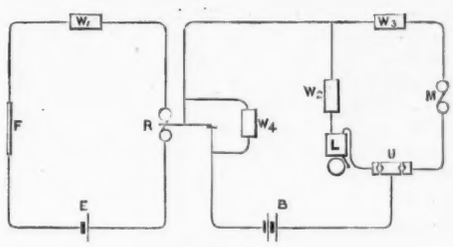


Fig. 2.

In the circuit of the coherer tube, F, there are, in addition to the battery, E, the resistance, W, and the relay, R. By means of the switch, U, either the calling up bell, L, or the Morse apparatus, M, with their respective resistances, W_2 or W_3, and the battery, B, can be thrown into the local circuit; W_4 is a resistance arranged in shunt to prevent sparking at the relay.

Such a station is called up when the tube is at rest, and the bell continues to sound until the Morse instrument is plugged into circuit, and the paper ribbon set in motion.

The diameter of the coherer tube to be employed in this way must not be too small, and the quantity of filings between the silver electrodes must be small enough to roll round the glass wall of the tube. When all the dimensions are properly chosen the dots and dashes stop at the right moment, and the signals are very distinct—certainly much better than with the old arrangement.

Search Lights and Defence.—A committee of naval and military officers at Portsmouth was engaged on Monday night testing the position of the electric search lights distributed among the forts and batteries of the Solent, and to determine whether it was possible for an enemy's torpedo craft to steal into Spithead and effect unperceived an entrance into Portsmouth Harbour under cover of the night.

ELECTRICAL ALLOYS.

By ROLLO APPLEYARD.

Ten years ago German metallurgists began to study the problem of mechanical and electrical permanence of the cheaper alloys used for resistance coils. They appealed to the Reichsanstalt. Metal founders submitted specimens for analysis and criticism, elaborate tests were made, and the results led to the favour and adoption of "manganin" and "constantan." There is still some doubt as to the durability of these alloys, but the evidence shows that, with proper precautions, manganin and constantan may be protected against all ordinary sources of deterioration. The history of that investigation deserves to be told in full, as an object-lesson upon the benefits conferred by a National Laboratory. It is all written in *Band II.* of the *Wissenschaftliche Abhandlungen der Physikalisch-Technischen Reichsanstalt*; parts of it have from time to time been quoted in the Electrical Review and other journals, but several important details have been omitted; it is therefore proposed here to give a summary of the investigation more or less as it appears in the original volume.

I. Metallic Alloys for Standard Resistances.

The first step was to investigate the electrical resistance of most of the familiar alloys, with the intention of elucidating the question of the variation of their specific resistances, for it is these variations that most disturb precise measurements. German silver was next examined, samples being taken from that made by Messrs. Siemens & Halske for standard resistances; also nickel wire from Obermaier, of Nürnburg, and platinum-silver and platinum-iridium from Messrs. Heräus, of Hanau. Of these alloys, the particular quality of platinum-silver examined was found to be too inhomogeneous and too brittle; it had, therefore, to be excluded from the final research.

Platinum-iridium, on account of its high price and great temperature coefficient, was discarded, as it was considered to be only of secondary importance for practical purposes. In the course of the experiments, the nickel used for coins in the Imperial Mint, and manufactured by Messrs. Basse and Selve in Altena, under the trade name of "Patent nickel," was carefully tested.

In order to characterise the materials as nearly as possible, analyses of the various samples were made in the Chemical Laboratory of the Reichsanstalt, with the following results:—

Table I.

—	German silver (1 mm.) Messrs. Siemens and Halske.	Nickel. (1 mm.) Messrs. Obermaier.	Patent nickel.
Copper	60·16	61·63	74·71
Zinc	25 37	19·67	0·52
Nickel	14·03	18·46	24·14
Cobalt	Trace	0·19	Trace.
Iron	0·30	0 24	0·70
Manganese ...	Trace	0·18	0·17
Tin	...	...	Trace.
Sp. resistance ...	30 0	33·2	32·8
Temp. coefficient	0·00036	0·00030	0 00021
Thermo-electric power against Cu.	14·4	18·1	29·1

For reference, three physical constants are added to the table:—(1) The *specific resistance* in microhm-centimetres; (2) the *thermo-electric power against copper* in micro-volts per 1° C., temperature difference; and (3) the temperature coefficient.

In the next case, the effect of rolling the wire was investigated at various adjustments of the rollers. Copper pieces were hard soldered to the ends of the wire under test, and the resistance was measured; then, avoiding tensile strain so far as possible, the wire was rolled, and finally its resistance was again determined at the same temperature.

All wires in Table II. show an increase of resistance after rolling, varying from 0·04 per cent. to about 0·87 per cent. Patent nickel varies least, German silver the most. If the diameter of the roller is 40 times that of the wire, only a very small increase in the resistance of the patent nickel wire is observed; with German silver the increase is about four times greater. If rollers of 10 times the diameter of the wire

Table II.

Specimen of wire.	Diameter of rollers.	Resistance in ohms. Before rolling.	Resistance in ohms. After rolling.	Increase per cent.
1. Standard German silver (Siemens and Halske) 1 mm.	20 mm.	2 2403	2·2575	0 77
	10 „	2 2460	2 2594	0 60
	10 „	2 2470	2 2666	0 87
	40 „	2 2425	2 2457	0 14
	40 „	2 2468	2·2561	0·41
	40 „	2·2440	2·2500	0 27
	10 „	1·9603	1·9698	0 48
2. Nickelin (Obermaier) 1 „	40 „	1·9977	2·0300	0·12
„ „ 1 „	10 „	2 0008	2·0024	0 08
„ „ 0·3 „	3 „	2 0099	2·0198	0 49
3. Platinum-silver (Heraus) ... ... 0 3 „	4 „	2·0205	2 0217	0 06
4. Platinum-iridium ... 0·3 „	3 „	2·01405	2 0190	0·25
5. Patent nickel ... 1 „	40 „	2·8687	2·8704	0 06
„ ... 1 „	10 „	1·1031	1 0035	0 04
„ ... 0 6 „	24 „	6 0106	6·0149	0 07
„ ... 0 6 „	6 „	2·9996	3·0054	0 23
„ ... 0 3 „	12 „	15·0748	15 0837	0 06
„ ... 0 3 „	3 „	5·0583	5·0973	0 77

are used, both of these alloys show a change of resistance of about four times the above increment. The cause of this increase of resistance by rolling is partly due to stretch, and partly to mechanical hardening, the result of bending and twisting.

Variations due to bending may be prevented very easily and effectively in standard resistances, by attaching the wires permanently to metal with a strong coating of shellac.

The quasi-permanent resistance-changes due to heating of the material are much more serious. In order to investigate them, bobbins of the foregoing metals were heated for several hours in a dry oven at 40° C., 100° C., and 150° C., and then again at 100° C., measuring the resistance before and after every heating. Table III., column 6, shows the alteration of resistance, corresponding to the various temperature ranges.

Table III.

Specimen of wire.	Duration.	Temperature.	Resistance before the heating.	Resistance after the heating.	Variation.
1	2	3	4	5	6
	Hours.	Degs. C.	Ohms.	Ohms.	Per cent.
1. German silver (Siemens and Halske). 1 mm	7	40	1·9698	1·9706	+ 0 04
	3	150	1·9706	1·9875	+ 0 85
	5	100	1·9875	1·9878	+ 0 02
2. Nickelin (Obermaier). 1 mm.	7	40	2 0000	2·0007	+ 0·04
	3	150	2 0007	2 0146	+ 0·69
	5	100	2·0146	2 0147	+ 0·01
	8	40	2·8704	2·8692	− 0·04
3. Patent nickel. 1 mm.	2	150	2 8692	2·8575	− 0·41
	2	100	2·8575	2 8576	+ 0·00₃
	8	100	2·8576	2 8577	+ 0·00₄
4. Patent nickel. 0·6 mm.	5	100	6·0149	6·0056	− 0·15
	4	100	6·0056	6·0048	− 0·01
	2	150	6 0048	5·9962	− 0 14
	3	100	5·9962	5·9963	+ 0·00₂
	14 days.	Room temperature.	5 9963	5·9964	+ 0·00₂
5. Patent nickel. 0·3 mm.	8	40	15·0837	15·0779	− 0·04
	2	150	15·0779	15·0067	− 0·47
	3	100	15 0067	15·0071	+ 0·00₃
6. Patent nickel. 0 3 mm.	6	40	5·0970	5 0945	− 0·05
	3	100	0·0945	5·0863	− 0·16
	2	150	5·0863	5·0726	− 0·27
	2	100	5·0726	5·0726	0

Patent nickel gives a diminution, German silver and nickelin an increase, of the specific resistance after heating. The first heating, 40° C., produces a slight but definite alteration with all the wires. With the next heatings, 100° C. and 150° C., German silver and nickelin have very nearly the same order of increase, which is approximately double of the diminution exhibited by patent nickel. Heat-

ing at 100° C., after previous long continued heating at 150° C., influences German silver and nickelin only very slightly; with patent nickel, as a general rule, there is no difference within the limits of observation. The important results derived from these experiments are: (1) that the specific resistance of German silver and nickelin can be made approximately constant, by prolonged heating at 150° C.; and (2) that the specific resistance of patent nickel becomes, within the limits of observation, perfectly constant under the same treatment, so that it does not undergo any subsequent changes even when heated to 100° C. Secondly, the experiments show that, of the materials investigated, patent nickel is essentially better than German silver and nickelin as a material for standard resistances. The above variations are considered by the Reichsanstalt to be due to the presence of zinc in the German silver and in the nickelin samples.

Resistance Alterations due to other Influences.—Of the other influences that can bring about variations in the resistance of metallic alloys, oxidation has first to be considered. The results show that shellac is effective in preventing oxidation, even with the alloys most liable to be attacked. The thermo-electric force of the above specimens against copper, brings about apparent changes of resistance. These changes are most observable with low resistances used with large currents; but by suitably designing the resistances and apparatus they can be nullified.

Of much more importance are the changes of specific resistance with temperature. There is no means for compensating these changes, they can only be held within limits by careful jacketing in oil baths, meanwhile observing the temperature of the oil. They constitute the principal cause of uncertainty in standard resistance coils, and they form the starting point of the investigations of the Reichsanstalt.

Klemencic studied the properties of platinum-iridium and several other alloys used as standards of electrical resistance. He investigated platinum-iridium, platinum-silver, German silver and nickelin, but without giving analyses of the samples. The Reichsanstalt have since examined some of the nickelin alloys used by him, and they find their composition to be :—

	Copper.	Nickel.	Manganese.
1. Bare wire	75·4	24·6	Trace.
2. Covered wire... ...	75·5	24·5	Trace.

thus corresponding with the patent nickel in Table I.

The different materials were tested with regard to their specific resistance, their temperature coefficients, and their thermo-electric force against copper, also the change of their resistance with time, the influences of mechanical deformation, and of moderate temperatures. As a result of the whole investigation, it is found that German silver is of all the alloys the least suitable material for standards of resistance, since it is the one most influenced by mechanical deformations. In this regard the Reichsanstalt conclusions agree with those of Klemencic. The temperature-changes in Klemencic's experiments, though comparatively small, were quite great enough to produce noticeable acceleration of the resistance variations. He himself says: "It would perhaps be possible to bring newly-constructed resistance coils to a final steady value by submitting them for a considerable time to a fairly high temperature." But he did not pursue this idea very far. In his investigations, platinum-silver, such as was recommended 30 years before by Matthiessen, proved the best; in the Reichsanstalt experiments, however, this material seemed to lack homogeneity. With regard to the use of "nickelin" (patent nickel) of standard resistances, Klemencic says: "it has many good properties, but its high thermo-electric power against copper, and the small degree to which it can withstand chemical actions, must be regarded as unfavourable." This alloy is very generally used in the construction of coils for ordinary resistance boxes.

(To be continued.)

American Pigs for the Clyde!—It is stated that a large quantity of American pig iron has been brought into the Clyde at 10s. per ton below the price for which English iron could be obtained in this country, and should it prove equal to specifications, it is said there will be a large importation.

SOME FACTS ABOUT WIRELESS TELEGRAPHY.

There have been many wrong conjectures and misconceptions in this country on the subject of wireless telegraphy. The controversy that broke forth on the question of allocating credit to the originators is no doubt still fresh in the minds of our readers. We are not anxious to revivify the differences that have marked the introduction of this new system of signalling, and to that end we shall, as far as possible, confine our remarks to the experiments that are being conducted in this country by Mr. Marconi. To begin with, however, an error perpetrated by a contemporary which still remains uncorrected ought to be swept away. The postal authorities are not conducting experiments on wireless telegraphy between Bournemouth and the Needles, and never have been. A want of knowledge has attributed to the Post Office what has really been done by the Wireless Telegraph Company, under the supervision of Mr. Marconi.

We have been in touch with the Bournemouth experiments for months past, and last week we had the privilege of taking some part in the transmission of messages between Bournemouth and the Needles by the methods of Mr. Marconi.

It is hardly necessary to say that successful experiments on wireless telegraphy have not been confined to this country. In Italy and Germany indefatigable workers have been able to give very remarkable demonstrations. The most noteworthy are those of Dr. A. Slaby, whose achievements have been often quoted in this country as a means of disparaging Marconi's work. Dr. Slaby himself is more generous, and at the present stage it is interesting to quote the following passages from his recent work :—

"Like many others I have also taken up this study, but never got beyond the limits of our High School. Even with the aid of parabolic reflectors and great capacity I could not attain any further.

"Marconi must have clearly added something new to the knowledge by which distances of a kilometre long were attained. I at once resolved to go to England, where the telegraph authorities were making greater experiments. Introduced through my friend Mr. Gisbert Kapp to Mr. Preece, chief engineer of the English telegraph administration, I was graciously allowed to participate in these. What I saw was something new; Marconi had made a discovery; he worked with means, the full importance of which had not been recognised, and which alone explain the secret of his success.

"I ought to have said this at the commencement of my subject, as later, especially in the English technical press, the novelty of Marconi's process was denied. The production of the Hertz waves, their radiation through space, the sensitiveness of the electric eyes, all are known. Very good; but with these means 50 metres were attained, but no more.

"In the first instance, Marconi has devised for the process an ingenious apparatus which, by the simplest means, attains certain results. He has thus first shown how, by connecting the apparatus with the earth on the one side, and by using long extended vertical wires on the other side, telegraphy was possible. These wires form the main feature of his invention; the term 'wireless telegraphy' is, therefore, really incorrect. It would be more correctly termed spark telegraphy, in contrast to the present telegraphy by the electric current.

"I will first of all discuss the constructive apparatus. The principal part of the apparatus is the electric 'eye.' After many experiments, Marconi considered a metallic powder, or rather a mixture of metallic powders, 96 per cent. hard nickel, and 4 per cent. silver, to be the best. It is produced by filing with clean and dry files. This mixture is sealed in a glass tube between two silver balls, the limited surface of which is slightly amalgamated with mercury. The finer the layer of powder, the more sensitive the 'eye,' *i.e.*, the lower the force of the rays, the better the action.

"The layer is only about ½ mm. thick, and only from 20 to 25 metallic grains can be introduced. The exact percentage of silver given is comparatively unimportant; it can only be said that a larger quantity of silver grains make the tube more sensitive, which is of no advantage, as the more silver, the more defective the interruption by concussion

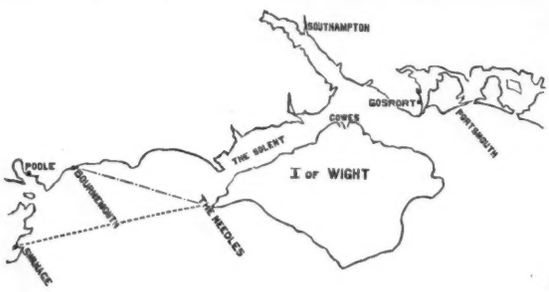
after signalling. To effect certain results, which is the main point, I entirely omit the silver, and use only nickel filings. Marconi further recommended the tubes to be exhausted after filling, and hermetically closed. The former is, according to my views, unimportant; the hermetical closing is, however, to be recommended, as it ensures the correct position of the confined silver plungers. The entry is effected by platinum wires, which are welded to the silver plungers. It is, however, of the greatest importance to select with the microscope, metal grains of the most uniform size possible, the sharp edged, jagged and pointed being the most acceptable, and the round grains being the least. Before filling they must be carefully cleaned and dried. In spite of everything one is, however, dependent on chance; some have always to be rejected, partly through having too little or too much sensitiveness, partly on account of an absence of capacity of interruption."

Dr. Slaby, after giving further details of Marconi's apparatus, proceeds to say:—

"Arriving home, I at once commenced to repeat the experiments. I constructed the apparatus in every respect according to Marconi's system. Several simplifications were made subsequently which have proved useful."

The evidence of Dr. Slaby ought to be fairly conclusive that Marconi had made distinct advances on anything previously attempted.

Returning, however, to the experiments at Bournemouth. It is perhaps necessary to say that the Wireless Telegraph Company have had since last November a signalling station at Bournemouth, and one at Alum Bay, on the Needles, Isle of Wight, the position of these places with regard to each other being clearly shown on the section of map. The distance between the two points is 14½ miles, and messages are sent between the two places with facility and accuracy. Swanage is to be very shortly brought into electro-magnetic communication with the Needles.



We have at different times spoken of the apparatus used in Marconi's system,* and at the moment it is scarcely important to refer to the principle in detail, especially as the quotation from Dr. Slaby includes an account of the chief features of Mr. Marconi's system.

A room in one of the houses facing the sea at Bournemouth is fitted up with the necessary apparatus for sending and receiving signals. Even in a locality where masts and flagstaffs are common, the height of the pole facing the signalling station would probably attract attention. It is about 115 feet high, and from the top of this is suspended either an insulated copper wire, or, as on the occasion of our visit, a wire netting some 9 inches in width may be employed. The wire netting is suspended from the pole by means of a long ebonite stick, two coils of wire at this point being employed in order to give an increased capacity. Means are, of course, taken to prevent the netting or the wire coming into contact with the pole. The end of the conductor is carried through a window into the room where the transmitting and receiving apparatus is arranged. Upon entering the room, the scene of such remarkable performances, one is struck with the simplicity, indeed, the sparseness of the apparatus. On a small table near the window is a large 10-inch induction coil, and a Morse key, which forms the sending apparatus, while close by is a metal box some 2½ feet in length, which contains the receiving apparatus, the coherer, a relay and the tapper, while an ordinary Morse printer completes the receiving equipment. A few cells arranged underneath the table completes the apparatus for sending messages across space. After an examination of the instruments, we had various special messages sent by the operator, with a request that they should be repeated; the messages were by no means easy, and, as one was a code message, there was no context to enable the operator at the Isle of Wight end to guess the words. Yet, difficult as it was, the code message came back exactly as it was sent. Altogether we were sending messages backwards and forwards for upwards of an hour, but in no single instance was there any trouble in reading the signals.

As we have already remarked, a 10-inch coil and a Morse key constitute the sending apparatus. The coil at the Bournemouth end is worked by means of a small battery of accumulators. The sparks from the induction coil are made to pass between two small brass balls, about ¾ of an inch in diameter, and placed about an inch apart. In the process of sending a message one sphere of the induction coil would be connected to the end of the vertical wire, while the other would be connected to earth. The operation of the Morse key, by regulating the passage of the current between the battery and the coil, governs the discharge between the spheres, and gives rise to the electro-magnetic waves in the length of vertical wire which affect the apparatus at the receiving station. It is interesting to mention, as showing the tendency to simplify the Marconi apparatus, that in the Penarth experiments it was necessary, for the purpose of transmitting signals over a distance of eight miles, to employ an 18-inch induction coil; but it has been found that perfect signals can now be obtained between Bournemouth and the Needles with a 6-inch coil.

It is necessary, when the sending and receiving instruments are adjacent to one another, to provide a metal screen between them.

Both at Bournemouth and at the Needles the whole of the receiving apparatus, with the exception of the Morse instrument, is contained in a metal box. We need hardly dwell at length upon the receiving apparatus; it consists merely of the coherer, the construction and action of which are well known. The coherer puts into action a one-cell battery, which operates a relay. The relay makes and breaks connection between a 12-cell battery and a Morse instrument, which prints the message. The coherer is about 1½ inches in length and about $\frac{1}{10}$th of an inch in diameter. When receiving a message the end of the vertical wire is connected to the coherer, which then becomes sensitive to electro-magnetic waves. The necessity of decohering exists, and to restore the coherer to its original non-conducting condition, after being affected by the electro-magnetic waves, which go to make a distinct signal, an electrical tapper is provided, which operates automatically and taps the coherer back to its normal state.

After spending a considerable time at Bournemouth dictating messages and having them repeated, we passed over to the Needles to examine the station there. The instruments are arranged in a room in the Needles Hotel, and are practically identical with those in use at Bournemouth. The vertical wire is attached to a mast about 150 feet high, though the entire height of the pole is not utilised. Messages were sent backwards and forwards for some time after we arrived on the island, and at 9 o'clock in the evening of the same day we again witnessed for about an hour and a half the transmission and receipt of messages. Moreover, we availed ourselves of the system to send a telegram to London, the message being sent from the Needles to Bournemouth, and there handed in at the local telegraph office. We had a further opportunity next day of testifying to the facility and accuracy with which signals could be sent and repeated, though it hardly necessitated these various tests to convince us of the successful working of the system. Many of the Morse messages we brought away with us, and a further examination of them demonstrates beyond doubt the clearness and strength of the signals. Admittedly the signals were slow, the average speed in transmission being probably no more than 12 words per minute, but it must be added that no attempts whatever had been made to send fast signals, the aim being rather towards reliability than speed.

The system has now been in use between Bournemouth and the Isle of Wight for some months, and the variations in weather have had practically no marked effect upon the

* A full description of Marconi's apparatus appeared in the Electrical Review for July 16th, 1897.

signals. If there is any difference, it is that foggy and stormy weather is the most favourable for the transmission of signals. The experiments have not been entirely confined to signalling between shore and shore. Quite a large number of successful results have been obtained in signalling between ship and shore in the very worst of weather. In this case a mast, 50 feet high, was erected on a steam tug, and gave excellent signals.

The next move in wireless telegraphy is the erection of a station at Swanage, which is 18 miles from the Isle of Wight; this is in course of construction, and no doubt will soon be in operation. A still more ambitious scheme is in contemplation, and that is telegraphing between the Isle of Wight and Cherbourg, a total distance of 60 miles. We need hardly say we shall follow these experiments with the greatest interest.

Mr. Marconi deserves the congratulations of all scientific men for the singularly able and ingenious manner in which he has brought wireless telegraphy to a practical issue.

Our thanks are due to Mr. Marconi and to Mr. Jameson Davis, the managing director of the Wireless Telegraph Company, for freely giving us information and permitting us to witness practical tests on the system.

INDUCTANCE IN TELEPHONY.

By W. MOON.

(*Concluded from page* 504.)

This condition being fulfilled, and E_m being constant, it will be found that the greater the difference between S and R when R + S = constant, that the greater is the current in the secondary circuit. For if the value of "λ" be filled in equation (2) it can be written

$$y = \frac{E_m}{\sqrt{\frac{(S^2 + p^2 n^2)(R^2 + p^2 L^2)}{p^2 M^2} + p^2 M^2 + 2RS - 2p^2 LN}} \quad (4)$$

and if p L, p N and p M be written as resistances since they are to bear a constant proportion to R and S they may be written p L $= n$ R, p N $= n$ S, p^2 M$^2 = p^2$ L N $a = a n^2$ R S. Filling these values in (4) it reduces to

$$y = \frac{E_m}{\sqrt{RS\left\{\frac{(n^2+1)^2}{n^2 a} + n^2 a + 2(1-n)^2\right\}}}$$

where the quantity in the brackets is a constant, and since the product R S is least at either end of the line, and greatest when R = S, it is evident that the nearer the transformer is placed to either end of the line the greater will be the current in the secondary circuit.

Moreover, at a particular point between the centre of the line and "E" the current in the secondary circuit would be equal to that in equation (3) where no transformer is used, and for any position nearer "E" than that point the current in (4) would exceed that in (3) in proportion to the nearness of the transformer to E. And this is the explanation of the use of the induction coil with telephone circuits, where the work done by the battery is much greater, and, consequently, the secondary current is much greater than if the microphone were used on the circuit direct.

The induction coils used with telephones are not of the closed magnetic circuit type. The primary current of a telephone induction coil is undulatory but not alternating, so that the inductances of such coils are single current inductances, and it is necessary to use coils with broken magnetic circuits having but little residual magnetism.

As the presence of a secondary circuit affects the impedance of a primary circuit, it is interesting to note the effect of sheathing such pieces of apparatus as indicators and transformers, as such sheathing acts in every way similar to a short-circuited secondary circuit.

If the value of "ν" be filled in the denominator of equation (1) the impedance of the primary circuit works out as

$$\sqrt{R^2 + p^2 L^2 + \frac{p^2 M^2}{S^2 + p^2 N^2}(2RS + p^2 M^2 - 2p^2 LN)},$$

from which it can be seen that the quantity in the brackets is positive when $2RS + p^2 M^2 > 2p^2 LN$, is zero when $2RS + p^2 M^2 = 2p^2 LN$, and is negative when $2RS + p^2 M^2 < 2p^2 LN$, and, therefore, that the current in the primary circuit is increased by the presence of a secondary circuit when $2RS + p^2 M^2 < 2p^2 LN$, and reduced when $2RS + p^2 M^2 > 2p^2 LN$.

Which of these two cases would result depends on the relative values of the resistances and inductances as well as upon the pitch of the voice. But generally it seems that it is not advisable to sheath telephonic coils with solid metals. And that if indicators are sheathed with iron to give them a magnetic circuit of less resistance that it would be advisable to split the sheathing from end to end to prevent it acting as a secondary circuit.

The inductance of a metal sheathing can be calculated from the measured inductance of a coil of wire occupying the same space and having n turns since the inductance of the sheathing would be $\frac{1}{n^2}$ that of the coil. And the mutual induction between the sheathing and the primary coil would be $\frac{1}{n}$ that of the primary coil and the coil occupying the space of the sheathing.

The cores of electro-magnets act as secondary circuits in the same way as an iron sheathing, and for this reason telephonic induction coils and transformers are provided with cores of iron wires oxidised on the surface. It is doubtful,

Fig. 5.

however, whether the insulation thus procured is all that could be desired. A more efficient core for an induction coil can be made by winding iron foil up in a coil with paper insulation between each turn, as shown in fig. 5, when the straight line represents the iron foil, and the dotted line the paper.

A transformer can be similarly made with iron foil in strips with paper insulation, as in fig. 6.

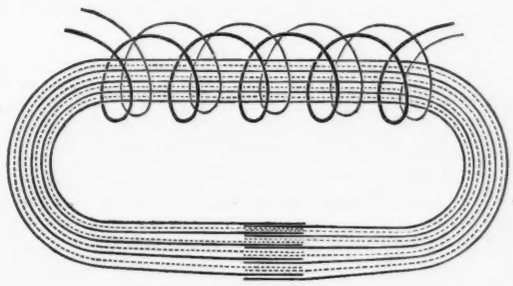


Fig. 6.

The advantage of these methods over the use of wire, is that apart from a better insulation, more iron can be got in the same space.

If, in a transformer in which the inductance of the two coils and the mutual inductance between them is equal, the inductance of the coils be separated from that of the lines by substituting $L_1 + M$ for L and $N_1 + M$ for N in equation (4) this equation reduces to

$$y = \frac{E_m}{\sqrt{\frac{(S^2 + p^2 N_1^2)(R^2 + p^2 L_1^2)}{p^2 M^2} + 2\frac{(R^2 + p^2 L_1^2) p N_1 + (S^2 + p^2 N_1^2) p L_1}{p M}}}$$

$$+ (R+S)_2 + {}_1(L_1 + N_1)^2 p^2$$

From which it can be seen that the greater M is made the nearer the current in the secondary circuit approaches

$$y = \frac{E_m}{\sqrt{(R + S)^2 + p^2 (L_1 + N_1)^2}}$$

In a tranformer in which $L N = M^2$ the current can be expressed in the number of turns of wire in the primary and secondary circuits. Let $L = n^2 K$, $N = n_1^2 K$, and $M = n\, n_1 K$. Then if these values of L, N, and M, be filled in equation (4) it reduces to

$$y = \frac{E_m}{\sqrt{\left(\frac{R\ S}{p\ n\ n_1\ K}\right)^2 + \left(R\frac{n_1}{n} + S\frac{n}{n_1}\right)^2}}$$

where "K" is a constant depending on the form and size of the transformer, and R and S are the resistances of the primary and secondary circuits which are free from inductance except in the transformer itself.

The mean E.M.F. of a generator can be measured by comparing the deflection produced in a galvanometer by half a revolution of the armature, with the deflection produced by the discharge of a condenser.

If a condenser of capacity "F," and charged with an E.M.F. "e," be discharged through a galvanometer then

$$q_F = F\, e,$$

and the discharge from the generator

$$= q_G = \frac{\Phi\, n_1}{\omega} = \int_0^{\infty} \frac{e_1}{\omega}\, d\, t,$$

where Φ is the flux of force and n_1 the turns of wire of the armature, and "ω" the total resistance of the circuit. Hence the mean E.M.F. generated when the armature revolves n times per second is

$$E_m = 2\, n\, \Phi\, n_1 = \frac{q_G}{q_F} F\, e\, 2\, n\, \omega.$$

Two generators of which the E.M.Fs. were thus measured gave 16 and 26 volts respectively.

It is found that telephone receivers speak much louder when they contain a permanent magnet, than when they do not. The action of the magnet in the receiver can be thus explained:—

The pull of an element of the diaphragm in the direction of the magnet is $\frac{\beta^2}{8\,\pi} \sin\theta\, d\, s$, where β is the induction and θ the angle the lines of induction make with the diaphragm. Hence the pull on the diaphragm is

$$\frac{1}{8\ \pi} \int \beta^2 \sin\theta\, d\, s.$$

Assume this equal to Φ^2. Then when a current passes through the coil of the telephone the flux would be altered to $\Phi \pm \Phi_1$, and the pull to

$$(\Phi \pm \Phi_1)^2 = \Phi^2 \pm 2\, \Phi\, \Phi_1 + \Phi_1^2,$$

so that the alteration in the pull that determines the motion of the diaphragm would be $\pm 2\, \Phi\, \Phi_1 + \Phi_1^2$. Obviously Φ_1 is much smaller than Φ, so that the loudness of the speech is proportional to the strength of the magnetism of the permanent magnet.

If a soft iron core, instead of a magnet is used, Φ still represents its magnetism, that is, its residual magnetism, and hence the speech is not nearly as loud.

CORRESPONDENCE.

Hoisting Gear for Street Lamps.

With reference to the Davy hoisting gear which you described in a recent issue (p. 469), it would, I fear, be very difficult to carry the steel wire rope round the semi-circle of the carrier on small rollers, as shown in the drawings. To start with, how is one to get the rollers in position in the hole, and supposing that possible, not much space is going to be left for the two cables.

The makers must have early recognised this difficulty, as the sample lamp at Bath, which is referred to in your article, had the steel rope extending from the top of the post to the end of the carrier, just above the contact springs; a sort of short cut, which does not look so neat as when the rope is entirely hidden, but which is effective enough.

In the 84 lamps which the Electric Construction Company, Limited, are now erecting at Bath, the steel wire rope is simply allowed to slide on the inside of the tube of the carrier, and the cables are kept from fouling it by means of a sheet-iron partition, which is slipped into the carrier before it is wired; the two electric cables resting side by side on this partition.

The writer thoroughly tested the first lamp-post and gear for Bath, and found this arrangement satisfactory, the extra friction due to the steel rope rubbing on the tube being apparently very small in comparison with the total weight requiring to be hoisted. A test was also made to see what the life of a $\frac{3}{16}$-inch diameter steel rope would be under these conditions, and it was found that the wear after 10 years of service might fairly be assumed to be inappreciable. The diameter of the rope is really governed by the question of how large a winch can be got into the space at disposal inside the post. A $\frac{1}{4}$-inch diameter steel rope and a 3-inch diameter winch seem about right.

There are several minor improvements in these lamps for Bath, thus two pawls working at half tooth are employed instead of one, and merely pushing the raising and lowering handle home lifts the pawls out of gear by means of a cone. The handle is fixed to an aluminium hand-wheel, so that in lowering the attendant may use his hand as a brake against the rim of the wheel. The contact is slightly different to the one you described, and it was found advisable to introduce a ball and socket joint immediately above it to allow for slight swaying in a high wind.

There can be no doubt that this raising and lowering gear has come to stay, and great credit is due to Messrs. Davy and Davies for introducing it. The fact that when the lamp is lowered it is automatically cut off from the circuit acts as an additional safeguard, besides the double loop of cable which was required. With the old-fashioned type of lowering gear was an additional expense, very liable to foul and kink, and the cause of an extra drop in voltage.

Corner brackets are a bit troublesome to fit with the gear, especially when there is a shop-door or window immediately below; but for tramway poles (especially centre poles), which also carry arc lamps, the lowering gear will be very useful, because trimming lamps with an ordinary ladder is a trifle dangerous, on account of the vibration and the live trolley wires close by, whilst, on the other hand, the traffic generally prevents a truck ladder being wheeled into position.

Ernest Kilburn Scott.

Jerry Wiring.

I had hoped the day of jerry wiring was over. Unfortunately, it is not. The specimen sent herewith is a sample of wire which I yesterday took out of an installation. This wire, you will see, is fair outside bell wire. I might mention that a large portion of this wire had been run under the floors without any casing, in holes bored in the joists. When will fire insurance companies learn that it is advisable, from their point of view, to safeguard their interests?

In justice to South Shields, I must mention that the work was not done by a South Shields firm.

Jos. A. Jeckell.

Blasting.

The communication from Mr. Barnes, in yours of the 8th, is very interesting. The points he mentions to help guard against a repetition of the serious accident which arose while testing detonators are useful, but it suggests to my mind a farther consideration. Is it not a mistake to allow unskilled persons to test at all? The sensitive bridge of a low tension fuse is easily broken, and thus the fuse is spoilt; hence the necessity for constant testing. But with good, reliable, properly constructed "*high tension*" fuses this is never so—once made good always good. I think the lesson to be learnt is: Use a good high tension fuse which needs no testing. I speak in their favour with a wide experience of 25 years.

Frank Brain, A.M.I.C.E.

Referring to the testing of electric detonators, your correspondent of the 8th inst. is in order in stating that, had the operator not tried to test the high tension electric detonator fuses with the magneto, all would have been well; but it is useful to those concerned that some of the points should be more directly referred to.

It cannot be too widely known that high tension electric detonator fuses cannot be tested for continuity *at all* without almost certain explosion, as will be realised by the sectional sketch in page 9 of Nobel's explanatory pamphlet, "Electric Shot Firing" (of which copy is enclosed).

Low tension electric detonator fuses (page 10) are preferably tested for continuity with a single cell and galvanometer, and then at a safe distance, or with the detonators thoroughly shielded.

Electric blasting being a safe method, is becoming very popular, and it is most desirable that all who use high or low tension electric detonator fuses, should obtain from the company who make, or the agent who supplies the goods, some explanatory instructions, such as Nobel's issue to customers, and there need be no danger.

In high tension electric detonator fuses the ends of the wires, touching the fulminating mixture, are about $\frac{1}{8}$th of an inch apart; it is, therefore, quite evident that they cannot be tested for continuity without the "arc" so formed firing the flash mixture, which in turn fires the detonating mixture.

In low tension electric detonator fuses the platinum wire bridge is continuous through the flash mixture, so that with a single cell and galvanometer one obtains a deflection of the needle, showing the circuit complete. As the electromotive force and current are so moderate, the platinum wire is not heated sufficiently to fire the composition.

In all matters pertaining to high explosives, the principal desiderata are a thorough understanding of the details, and the exercise of a little thought and ordinary care.

Nearly every mishap or accident is due to an omission or a commission of some kind on the part of the manipulator.

John Mackenzie,
Electrical Engineer.

The Welsbach Incandescent Electric Lamp.

It would, I think, have increased the definite information on this subject if Mr. Gibson in his very able article had given the claims of Dr. Auer von Welsbach's patent which has been laid open for public inspection, and the subjoined translation of same, though possibly not literally accurate, will probably be of service :—

Claim 1.—Filaments for incandescent lamps, consisting of—
(*a*) Osmium, or;
(*b*) Osmium with a percentage of other platinum metals, such as platinum, iridium, ruthenium, or;
(*c*) A core of osmium with a coating of thorium oxide, or;
(*d*) A core formed from an alloy of osmium with the platinum metals mentioned under 1 (*b*), or of these metals or alloys of same and coated with thorium oxide.

Claim 2.—A process for the production of the filaments described in 1 (*a*) and (*b*), wherein,
(*a*) Osmium or osmium compounds are metallically deposited on a thin metal wire (core) by the reduction of a volatile osmium compound such as the tetroxide in reducing gases, and this core afterwards volatilised by incandescence, or;
(*b*) Osmium or osmium compounds are repeatedly spread in thin layers on to thin metal wires (cores) using a cementing material if desired, and the metal wire (core) then volatilised by incandescence, or;
(*c*) Osmium or osmium compounds are electolytically deposited on to a metal wire (core) and this core afterwards volatilised by incandescence.
(*d*) Osmium or osmium compounds in pasty form are repeatedly spread in thin layers on a vegetable or animal fibre (using a cementing material if desired), and converted into osmium by incandescence.
(*e*) Osmium or osmium compounds are made into an emulsion with collodion, denitrated and incandesced.

Claim 3.—A process for the production of the filaments described in 1 (*a*), (*b*), (*c*), (*d*), for electric lamps wherein thin layers of thorium oxide are successively and repeatedly spread on to the filaments mentioned and incandesced after each coating and the process repeated until a dense casing of thorium oxide has been formed on the filament.

In regard to these claims, as far back as 1878 (No. 5,306), Edison patented a filament made of platinum, platinum-iridium alloy, or other metal, which fuses at a high temperature, and is pyro-insulated by being coated with a metallic oxide, such as lime or magnesia, cerium or zirconium, which is not injured by a high degree of heat, and in a subsequent patent (1879, No. 2,402), he mentions the use of wire so coated in a vacuum, whilst in 1888 (No. 2,438) Mr. Langhans described thorium oxide as a filament for an incandescent lamp, and the coating of wires electrolytically with this material is also described by him in No. 23,137 of 1895.

The impregnation of carbon filaments with salts of the platinum group of metals is frequently the subject matter of patents between the years 1878 and 1892.

H. E. Moul.

Rubber Cables.

In connection with the late scare and damaging statements made concerning the behaviour of rubber-insulated cables at Burton-on-Trent, it would no doubt interest your readers to know that, according to the abstract of accounts for that undertaking published in one of your contemporaries in 1896, the cost of repairs and renewals of mains was only £15, and in 1897 on a capital expenditure on mains of £14,335, the cost of repairs and renewals for the year was only £16.

Wm. E. Gray,
Electric Light Department, Silvertown.

"Note on Condenser Shunts."

Owing to my own omission of certain words in my rough manuscript, the final paragraph in the "Note on Condenser Shunts" in the last issue of the Electrical Review is ambiguous. May I be allowed to supply the words omitted by me?

"The above diagram shows how an ordinary quadrant pole-reverser may be used either for Gott or for Thomson mixing connections. For the latter the sliding contact is direct to earth, and G with make-and-break key inserted between either of the capacity quadrants and earth, 1 and 2 being plugged for charge, and 3 for mixing."

E. Raymond-Barker.

April 15th, 1898.

MUNICIPAL ELECTRIC LIGHTING.

An interesting and instructive paper on "Municipal Electric Lighting" was read by Mr. W. C. C. Hawtayne, consulting engineer, at the Bishopsgate Ward Club recently. There was a large and influential attendance of members, including the chairman of the Watford Electric Lighting Committee, Mr. A. E. Pridmore, Mr. H. H. Richardson (solicitor to the Watford Ratepayers' Association), and many others.

Mr. Hawtayne's paper struck at the root of the whole question in the first paragraph, "who are the proper persons to undertake the work, local authorities or private companies?"

Beginning with a short history of the introduction of the dynamo, arc lamps and incandescent lamps, giving the several dates on which they made their advent, Mr. Hawtayne passed on to the time, only a few years ago, when the business men put their heads together and the voice of the promoter was heard in the land. To awaken interest in the new industry, the 1881-82 exhibition at the Crystal Palace was held, and many for the first time were able to see for themselves what could be done, and the great possibilities of the electric lighting in the future, and no difficulty was experienced, when batches of companies were floated, in obtaining money, for, to use the words of the author of the paper, "the general public went electricity mad."

Many companies immediately obtained provisional orders from the Board of Trade to supply electricity in the larger towns, and a table is given, which we reproduce below, of the provisional orders granted in 1883.

—	Granted.	Revoked.	Still in force.	
			Companies.	Local authorities.
1883	69	62	...	7
1884	4	4	...	...
1885	...	...	...	...
1886	1	...	1	...
1887	...	...	...	...
1888	...	...	...	...

In 1888, a new Act of Parliament which eliminated most of the drawbacks of the Act passed in 1882, had the effect of resuscitating the business of town lighting in 1889, when it was in the hands of

the true friends of electricity supply, and the progress which has taken place since then is apparent on every side of us.

In 1889, nine companies obtained provisional orders and only one local authority; last year 42 local authorities and only eight companies, and only one of the companies' orders were for a new undertaking. These figures are at last convincing of the soundness of the business of electricity supply.

In 1890 the total number of 8-candle-power lamps supplied from central stations was under 200,000 in London, and in the provinces *nil*. In 1897 London had no less than 1,831,000, and the provinces 2,130,000. In London companies supply nearly 1,700,000 and the local authorities less than 150,000, whereas in the provinces companies only supply 600,000 and the local authorities 1,600,000.

These figures speak for themselves. It is not to be expected that local authorities will exploit a new industry; this must be done by companies interested in that particular industry. When it is demonstrated that the business is sound and contains no element of risk, then is the time that local authorities step in, and this is what has happpened. London is no doubt suffering, especially in the City, through what may be called their throwing away of a chance in allowing companies to secure the orders, but we think, for the reason given above, it was absolutely necessary for companies to exploit the new industry, and where could this be done better than in London? Moreover, a great many orders secured by companies were orders obtained simply by manufacturers of electrical machinery, whose members were also members of the various companies. This served a double purpose, namely, provided a market for their electrical wares and demonstrated the utility and sound commercial nature of the industry. Manufacturers have benefited by the change in the enormous amount of business done, and perhaps the only individual who has suffered by the action of the local authorities is the company promoter, and who cares for him?

Mr. Hawtayne gives a long list of reasons for municipalisation, many of which were advanced by the Town Clerk of Douglas, Isle of Man, in a report compiled by him some time ago. They are so strong and clearly stated that we venture to reproduce them here:—

"1. It is generally admitted that a municipal authority can borrow the necessary capital for the initial outlay under more favourable circumstances than can be done by any private company.

"2. By municipalisation the capital applied to the purpose would not be increased by promotion expenses, or by the result of early failures, as is the case with so many companies.

"3. Electric light can be supplied by a corporation at a price so as to be profitable; less than that which would be charged by a company, because the latter must charge a price sufficient, after payment of all working expenses to provide a good dividend for its shareholders.

"4. By municipalisation the corporation would simply require to make a sufficient profit to pay the interest on the amount of borrowed capital.

"5. Where the installation is carried out by the corporation, it is not necessary to increase working expenses by payments to directors for administration, and consequently municipalities can manage more economically than companies.

"6. If the business which would accrue should be so profitable as to be greater than the interest required for money borrowed, this additional profit might not only be applied with advantage to the reduction of the rates, but also towards the very large expense which would be incurred in lighting the public streets and thoroughfares.

"7. In the event of the corporation deciding to allow a company to undertake the installation, the first step of the company—assuming that the conditions imposed by the Imperial Parliament would apply locally—would be to select a compulsory area, limited in extent, but which would certainly comprise the choicest portion of the town, from an electric lighting point of view. Ratepayers within the limits of this compulsory area would be able by the use of the electric light to make their places of business more attractive, to the detriment probably of the ratepayers outside, who could not demand a supply for two years, and could then only obtain it under onerous conditions of guarantee, &c.

"8. Where installations are in the hands of companies, the progress and growth of the undertaking is necessarily slow. Shareholders naturally believe in quick returns, and insist upon immediate and good dividends as the precursor to any contemplated enlargement of the capital account. From the beginning business is cramped and really obstructed for want of capital, with the inevitable consequence that the unfortunate ratepayers in the outside area are left out in the cold.

"9. A corporation can afford to take broader views than a company, and in the event of the business being sound as a commercial concern justifying extensions, the object of the corporation would be to develop it on an extended basis as expeditiously as possible. The municipality could afford to provide capital extensions without the necessity of waiting for a 5 per cent. or 6 per cent. dividend upon the work in the compulsory area, the principal aim, with due regard to permanent profitable results, being for a corporate body to extend the benefits of electricity supply throughout the whole of the borough.

"10. The corporation would be in itself a good customer in the direction of public lighting. The drawback to the electricity supply industry is that arising from the fact that the demand ceases almost entirely at bedtime, and economical working is greatly increased if the load can be continued far into the night.

"11. Municipal authorities—Esau-like—in numerous instances, have sold their birthright by sacrificing the monopoly in gas and water, and the same blunder, it is contended with reason, would be perpetrated by sanctioning the creation of a similar monopoly in the hands of a company providing an installation of electric light.

"12. Experience demonstrates that ratepayers as a body will support an undertaking in which, as ratepayers, they are personally interested as predominant partners more readily and more extensively than a concern which they naturally look upon as a private monopoly worked for private gain only.

"13. The most important reason, however, which is urged is that by retaining the manufacture and supply of electrical energy in its own hands, the corporation retains for itself the entire control of the whole of the industry, while it at the same time applies to the use of the ratepayers a system of sanitation as beneficial to the public as the system of water supply or that of drainage.

"14. Because with increased demand the cost of production will become infinitely less while the price charged to the consumer can remain the same if desirable.

"15. That with reduced charges the demand is bound to increase. At present electricity has been supplied for little else than lighting, but great advances are being made in electric cooking and heating, and, of course, in motive power work, and I might safely say that within a few years' time every tramway in the kingdom will be driven by electricity. Now the most serious bar to a reduction in the price of supply lies in the fact that with an ordinary lighting load the plant is only working at its maximum load, that is its highest efficiency for about two hours per diem, during the remainder of the day the standing charges are going on and the sales are infinitesimal. Think what a difference there will be when electric cooking and heating are in favour and tramways are working for 15 hours a day.

The traction load will in most of the large towns be larger than the lighting load, and many tramway companies have already arranged with local authorities or supply companies to take their supply of electricity from the lighting station, in some cases the price to be charged not to exceed 1½d. per unit.

"16. That the municipalisation can do their public lighting at cost price. Some local authorities say that they will light the streets at cost price, neglecting all depreciation and management expenses because they say we are making a profit out of our private customers. 'The works are there to supply them whether we supply the public lamps or not, so we will only charge the ratepayers for public lighting the extra cost involved by keeping the plant running a little longer and for the extra fuel, &c., consumed and the upkeep of the lamps."

Mr. Hawtayne's paper should be read by every member of the councils in the different towns and cities where the question of electric lighting is being considered. Unfortunately sufficient thought is not always given by those gentlemen when considering this momentous question, perhaps on account of the lack of such useful information as the paper under consideration affords, and which is presented in a light and, in language free from technicalities, easily understood.

The question of electric traction for tramways is engaging the minds of local authorities who have established their stations, and this fact, combined with the lighting question, should awaken double interest in the minds of those who have the deciding for and against allowing companies to step in and secure orders which have the effect of keeping up the price and depriving the poor man of his light, for, undoubtedly, the electric light is the poor man's light, and we confidently think electric traction the poor man's brougham.

BUSINESS NOTICES, &c

Agency Notice.—We understand that Messrs. Gudgeon and Co., of 85, Finsbury Pavement, E.C., are the newly-appointed agents for Messrs. Flather & Son, electrical engineers, of Leeds.

Announcement.—Mr. G. Stegmann, of Clapham Junction, has taken larger premises at 45, St. John's Hill, Clapham Junction, where he intends opening electric light showrooms.

Catalogues.—Mr. James White, of Cambridge Street, Glasgow, has brought out a new price list of Lord Kelvin's electrical instruments, also other apparatus for central station and laboratory use. The list is bound in brown cardboard covers, is well printed, and a good enamelled paper is used, showing off the excellent illustrations to best advantage. Among the many instruments of which detailed descriptions are given, we observe the Kelvin standard direct-reading electric balances, standard watt balances, special standard ditto, Kelvin's standard electrostatic voltmeters of various types, dial central station voltmeters, recording ditto for direct currents, astatic recording ditto for alternating currents, Kelvin's ampere gauges, engine room wattmeter, testing set, Kelvin's electricity supply meter, Kelvin's continuous rheostats for current regulation, galvanometers, resistance coils, and Wheatstone's bridges, electrometers, &c. In the engineering and general apparatus section is Amsler's planemeter for determining the mean pressure in an indicator diagram, Thompson's indicator, tachometers and speed indicators, and pyrometers. The conditions and fees for Board of Trade instrument tests are given at the end of the catalogue.

Messrs. Fuller & Co., of 28, Bush Lane, Cannon Street, E.C., have issued new catalogues dealing respectively with telephones and fittings. The telephone list gives numerous illustrations, weights, prices, and code words of various telephonic apparatus and accessories. Portable telephones, wall and desk apparatus, extension bells, intercommunication boards, exchange switchboards, lightning arresters, safety fuses for protecting telephones from high tension currents, also diagrams of connections for systems of various dimensions are given in this list. The electric light fittings catalogue shows a variety of plain and ornamental brackets, some very neat designs in electroliers, standards, pendants, shop lighting fittings, ships' fittings, arc lamp-posts, and various acce sories.

Electrical Wares Exported.

Week Ending April 19th, 1897	£	s.
Adelaide	68	0
„ Teleg. mat. ...	36	0
Baltimore. Teleg. mat.	19	0
Beira	37	0
Bombay...	12	0
„ Teleg. mat.	16	0
Buenos Ayres	175	0
„ Teleg. mat.	97	0
Calcutta...	324	0
Cape Town	288	0
East London	601	0
Gibraltar	15	0
Hamburg	328	0
Melbourne. Teleg. mat.	25	0
Monte Video	114	0
Otago	215	0
Passages...	280	0
Port Elizabeth... ...	292	0
Rosario	628	0
St. Lucia. Teleg. mat.	100	0
Sanda Ram	36	0
Singapore	12	0
Trinidad. Teleg. mat.	13	0
Total ...	£3,731	0

Week Ending April 19th, 1898.	£	s.
Albany	80	0
Alexandria. Teleph. mat.	34	0
Amsterdam	120	0
„ Teleg. wire	30	0
Auckland	29	0
Bangkok	122	0
Barcelona	41	0
Batoum. Teleg. mat....	180	0
Beira. Teleg. mat. ...	1,155	0
Bombay. Teleg. mat....	50	0
Boulogne	139	0
Buenos Ayres	220	0
„ Teleg. mat.	350	0
Calcutta...	337	0
Cape Town	2,100	0
Colombo	308	0
Copenhagen. „ „	55	0
Delagoa Bay	500	0
Durban	423	0
East London	255	0
Genoa	70	0
Geraldton	80	0
Hamburg	110	0
Hong Kong	28	0
Madras	331	0
Melbourne	169	0
New York	150	0
Ostend	30	0
Port Elizabeth... ...	1,723	0
Rockhampton	9	0
Rotterdam. Teleg. cable	16	0
Santander	28	0
Shanghai	1,000	0
Singapore	150	0
„ Teleg. mat.	25	0
St. Petersburg	250	0
Stockholm	255	0
Sydney	150	0
Tientsin...	11	0
Townsville	67	0
Valparaiso	167	0
Wellington	326	0
„ Teleg. mat.	2,847	0
Yokohama	437	0
Total ...	£15,607	0

Foreign Goods Transhipped.

	£	s.
Yokohama	240	0

Electric Lifts.—The City and South London Railway Company has placed the order for the whole of the electric lifts required on their new Islington extension in the hands of the United Ordnance and Engineering Company, Limited, of London and Erith, with whom Easton, Anderson & Goolden, Limited, are now incorporated. Each lift will be fitted with their patent gear, and will be capable of carrying about 70 passengers, and the average stroke will be 72 feet. The current required for working will be supplied from the generating station of the railway company. This firm has recently adapted one of the hydraulic lifts on the Stockwell section of this line so that it is now worked by electricity. The United Ordnance and Engineering Company, amongst other work of this class, has in progress five electric lifts for the new Brighton Tower, three of them serving to the 80 feet level, and two to the top of the structure, which is over 500 feet high, the speed of the latter lifts being 300 feet a minute, and each carrying 30 passengers. They are also supplying to the Royal Agricultural Hall a large electric platform lift to raise two tons.

Electric Organ Blowing.—The new organ which is being put down at Lincoln Cathedral is being supplied with electric blowing apparatus by Messrs. Bergtheil & Young.

Extension Granted of the Parsons Patent.—Before the Judicial Committee of the Privy Council (present—Lord Watson, Lord Macnaghten, Lord Davey, and Sir Richard Couch) a petition was heard on 19th inst. for the extension of the term of letters patent dated April 23rd, 1884, granted to the Hon. Charles Algernon Parsons for an invention of "Improvements in rotary motors actuated by elastic fluid pressure and applicable also as pumps." Mr. Moulton, Q.C., and Mr. A. J. Walter were counsel for the petitioner; the Attorney-General and Mr. Sutton for the Crown. It was stated, says the *Times* report, that the invention related to machines known as steam turbines. Prior to the date of the petitioner's letters patent no steam turbine was, so far as the petitioner was aware, in practical use within the realm. Many persons had endeavoured to employ the velocity of steam generated in a boiler for the purpose of causing constant revolution in one direction of moving parts without the use of the reciprocating apparatus commonly in use in engines actuated by steam, but, so far as was known to the petitioner, no practical machine had, at the date of his patent, been devised which would enable steam to be used in this way. At the time when the petitioner first devoted his attention to the subject of steam turbines no one had worked out the conditions essential to the manufacture of a practical turbine which would be capable of working with an efficiency in any way comparable to the efficiency of steam in engines of the reciprocating type. The petitioner, after many experiments and long and exhaustive research, was enabled to produce a practical steam turbine, and to lay down the conditions essential to the successful working of such a turbine. In order to do this the petitioner had to practically and theoretically work out the proper relations between the velocity of the moving parts and the velocity of the issuing steam acting upon them, and by a system of alternate rows of fixed and moving blades he was the first to devise a working machine and to proportion the parts of the machine so as to produce a practical working turbine. The high speed at which, in order to obtain the best results, it was necessary to run the moving parts rendered it essential that bearings of a novel description should be invented, the bearings being provided with a certain amount of elasticity, so that the moving parts would rotate around their centre of gravity, or principal axis, instead of around their geometrical centre or axis, so as to prevent vibration and shaking. The petitioner had also been able to eliminate one of the great difficulties attaching to steam turbines known as the thrust. In introducing the invention, the greatest opposition was encountered from engineers, engine builders, and others, and so little was known of the practical value of steam turbines at that time, that it was generally believed, in the engineering world, that no steam turbine could be constructed whose efficiency would approach the efficiency of the ordinary reciprocating engine. Many turbines constructed upon the principle of the invention were, however, now in use for the purpose of driving electric lighting and other machinery, and the public appeared now to have recognised the merits of the invention. Evidence was given as to the great merit of the invention. Machines made in accordance with the invention were now being largely adopted, and were being bought all over the country. One of the machines had been fitted to a vessel 100 feet long, which attained a speed of 34½ knots, a speed which it was believed would be increased if the machines were fitted to larger vessels.—Lord Kelvin was called as a witness in support of the petition, and said there was no practical steam turbine before the petitioner's. The petitioner's invention gave, for the first time, a practical steam turbine. There was a great future for steam turbines. The petitioner's invention had given very good results, and for many purposes it was going to supersede the reciprocating engine, and its application to ships was a very great step indeed.—Lord Watson said their Lordships would humbly recommend her Majesty to grant an extension of the patent for a term of five years, and they would state their reasons for coming to that conclusion on a later day.

Langdale, Hallett & Co. v. Russell & Lennard.—Before his Honour Judge Lumley Smith, Q.C., in the Westminster County Court on Wednesday, the plaintiffs, builders, of 122, Brompton Road, S.W., sued defendants, formerly in partnership as electrical engineers at 135, Victoria Street, Westminster, for £24 5s. 10d. for work done at 41, Bedford Square in connection with making good the walls there after cutting them for defendants to put in electric fittings, they having the contract for the installation. Judgment was given for the plaintiffs.

Liquidation Notice.—A meeting of the Electric Traffic Syndicate is to be held at 6, Old Jewry, E.C., on May 23rd, at 2 o'clock, to receive an account of the winding-up operations from Mr. Maurice Jenks, the liquidator.

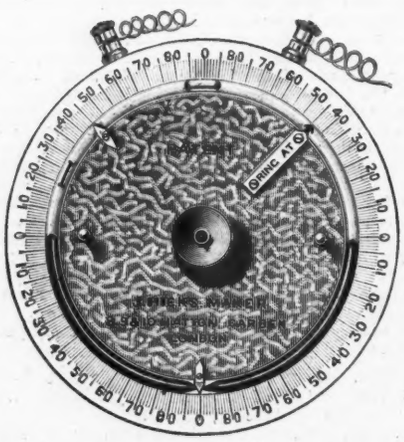
Melbourne Working Men's College.—We have received a copy of the 1898 prospectus of this College, giving full particulars regarding the different subjects in which instruction is given, and photographs of some of the workshops and class rooms. Mr. W. N. Kernot is the instructor in the electricity department, and Mr. L. S. Daniel is instructor in telegraphy.

Police Electric Lamps.—A sub-committee of the Cardiff Watch Committee has instructed the head constable to report on the subject of electric lamps for the police.

The Shannon Electric Power Scheme.—So many erroneous impressions prevail with regard to this project, that Mr. W. T. Fuller, engineer to the syndicate, writes to a Dublin paper, giving a brief description of the scheme. Originally the desire was to utilise the various lakes of the Shannon River as storage reservoirs which should ensure a sufficiency of water for the power required during the summer; in short, it was desired to use these natural reservoirs to equalise the variable flow of the stream to a certain extent, ensuring a fixed summer quantity, greater than the normal, between Lough Derg and Limerick. In this scheme of storage Lough Allen was included; a certain volume of water would have been retained there to supplement the flow into Lough Derg when the quantity required from that lake exceeded the supply entering it at the upper end. This procedure was said to spell ruin to the fishing industry, and rather than force it Mr. Fuller advised the directors to revert to the use of steam during periods of drought, and to leave the summer flow untouched. Various objections have been raised to the company's proposals. The intention to develop a certain amount of power, with its necessary abstraction of a small share of the river, is considered to be generally objectionable. Side by side with that statement, however, "we are told," says Mr. Fuller, "that were we to take four or five times the amount of water, and develop four or five times the amount of power at once, we should deserve support; and, although the original proposal was to develop 5,000 H.P. only all the year round, and although the present intention is to develop 5,000 H.P. all the year round, and in addition another 5,000 H.P. during wet periods, it has been publicly stated that the capacity of the works has been decreased. These things must speak for themselves. I shall content myself with pointing out that even 10,000 H.P. is a very considerable factor in the industrial life of a community, and that

the argument that no one should erect a water mill unless it takes the whole power of the river concerned, is a novel one. The intake and outlet of the power canal are separated by about a mile of river, containing fisheries. Down that river flows a volume of water, varying from one and a quarter millions of cubic feet per minute to one considerably smaller. The height of the flood water at Castle Connell frequently prevents good sport. Of that flood, it is proposed to divert a comparatively trifling amount and return it to the stream lower down. When the water is there, part of it will flow night and day, *viâ* the canal; when it isn't there, the generators will be steam driven."

Ships' Clinometer.—We illustrate below Hicks's new patent ships' clinometer, which has been designed to register the exact roll of a vessel at sea, or when listing to port or starboard. The clinometer shown is made entirely of metal, and the acting part consists of a circular tube containing mercury, with a contraction in the lower part to avoid undue oscillation, and is fitted with electric connections so as to record any particular roll of the ship in the captain's cabin or other place. For instance, if the captain desired to be warned should his vessel roll as much as 45°, he would place the small metal pointer marked "ring at," with arrow attached, opposite that point, as shown in the illustration. This is done by slightly releasing the milled screw head in the centre by giving it a few turns to the left



and then turning the pointer gently by the aid of the brass pins until the plate "ring at" is opposite the 45° or other desired point, clamping the disc again by turning the milled head to the right. Should the vessel ever roll sufficiently to cause the mercury to reach this point, contact is instantly made, and a loud warning bell would be rung. The bell can be placed at any desired distance away from the clinometer. This instrument has also an index to record the greatest roll. To re-set the index, release the milled headed screw and turn the disc round as described above, but it must be turned sufficiently to cause the mercury to pass round the tube and drive the index back. If it is desired not to cause the bell to ring when the index is being set, contact is broken by removing one electric wire from the terminal, replacing it after the index has been pushed round. The small quantity of fluid shown on top of the mercury is creosote, which is placed there for the purpose of always keeping the mercury pure and bright.

ELECTRIC LIGHTING NOTES.

Aberdeen.—The Beach Bathing Station is to be lighted by electricity at a cost of £170.

Ayr.—On the proposal of Mr. A. J. Fuller, the electrical engineer, 23 additional arc lamps are to be used for street lighting.

Bedford.—The Electric Lighting Committee proposes inviting tenders for a new sub-station, also a new engine room at the electricity works, and for a 10-ton overhead travelling crane; and further, for a 30 unit dynamo. Application is to be made to the Local Government Board for sanction to borrow a further sum of £5,400 for electric lighting purposes.

Belfast.—The Electric Committee have under consideration the public lighting of some of the principal thoroughfares, to be carried out when the new station is working, and have instructed the engineer to prepare a statement of the comparative cost of gas and electric light. The report for the first quarters' working of this year shows that the output is 55 per cent. greater than for the corresponding quarter of last year. The statement of accounts for the year ending December 31st, 1897, also shows the department to be in a prosperous condition, the lamps connected being equivalent to 21,000 8-C.P.'s, whilst the average price obtained per unit is 6·035d., with a total of 201,832 units sold.

Bromley.—Mr. Ernest Newton is to design the central station buildings for the Bromley Electric Light Company, the site chosen being approached from West Street. It is stated that £7,000 out of the £20,000 required has been subscribed, and that a gentleman has offered to subscribe the remainder provided he receives a seat on the board of directors, but the offer has been declined.

Camberwell.—The Vestry has adopted the recommendation of the General Purposes Committee mentioned in our last issue, and will not proceed with the proposed purchase of the undertaking of the County of London and Brush Company.

Cheltenham.—A new "set" has been erected at the generating station, and a preliminary run was made the other day with the arc lighting load before putting it on the actual service of the town. It stood the trial to the entire satisfaction of the engineers, and in the evening took up the greater part of the street and private lighting without mishap of any kind. The new set consists of a Belliss engine direct coupled to a Siemens alternator, and has a capacity of about 250 kilowatts. It is the sixth set, so far, laid down. Three were in running when the works were opened nearly three years ago, viz., two with a capacity of 33 kilowatts each, and one of 110 kilowatts. Since then two other sets have been added, each of 110 kilowatts, and the one now erected has a capacity exceeding these two combined. Another of a capacity equal to it is now on order, and will be delivered in time to meet next winter's load. The committee already has authority to order another set of 400 kilowatts capacity, when occasion requires. All the sets have the Siemens alternator, but while the first three are driven by Willans engines, those since erected are engined by Belliss, under contract with Messrs. Siemens. The new set should have been in place before Christmas, but delivery has been delayed until now by the engineers' strike.

Colwyn Bay.—At the last District Council meeting the surveyor produced plans and specifications for the contract for lighting the promenade with electricity. He had every reason to believe that if tenders were advertised for at once the scheme might be completed by August 1st. Mr. W. Davies was inclined to believe that the town stood in as much need of electric lighting as the promenade. It was agreed to advertise for tenders forthwith.

Mr. Clirehugh has approved of the Ivy Street site.

Dewsbury.—We hear that for the post of borough electrical engineer there were about 60 applicants.

Dublin.—The Town Clerk asked the Corporation for instructions regarding the recommendations set forth in the report of the committee of the whole house relative to the proposed new electrical station at the Pigeon House Fort. The Corporation, after considering the matter, passed a resolution referring to a committee of the whole house to consider the entire question of the new station, the question of site, and also submitting the question of the station and scheme to the best electrical experts for advice; to suggest methods of raising the necessary money for erection and equipment of a station to supply current for lighting the entire city; to advertise for tenders for carrying out the work, and report thereon.

Dumfries.—The Provost's Committee of the Town Council is considering the question of electric lighting.

Ealing.—The Clerk has reported that now, at the end of the first three years of the Council's working of the electric lighting undertaking, 15,209 lamps had been applied for, and of these, 14,495 had actually been connected. The original estimate was for 5,000 lamps within the first three years.

Edinburgh.—The Lighting Commiteee has again considered its previous recommendation regarding the lighting of a number of additional streets—which recommendation was not approved by the Council—and has resolved to adhere to its proposal with a slight modification.

Hackney.—There is much dissatisfaction expressed locally at the unreasonable way the Vestry has been playing with the electric lighting question during the past few years, and ratepayers are beginning to feel that the Vestry is unable to settle matters satisfactorily by itself. Therefore the ratepayers requisitioned for a special meeting of the inhabitants, and this was held on Monday, the chairman of the Vestry presiding. The meeting passed, by 500 votes to 3, a resolution to the effect that the Vestry should keep the provisional order in its own hands. Mr. Henry Hulland, the chairman of the Electric Lighting Committee, argued that the Vestry could re-purchase the order at the end of 12 years as a going concern, and that if the proposed scheme was carried out the company would collect the house refuse to be consumed at the generating station and save the parish £5,000 a year. The prices to be charged by the company in Hackney would be considerably lower than in other London districts.

The Vestry met on Wednesday to receive the report of the Electric Lighting Committee, which recommended the transference to a company. In the heated speeches various charges of "treating" and corruption were made, and the matter was adjourned until after the next elections.

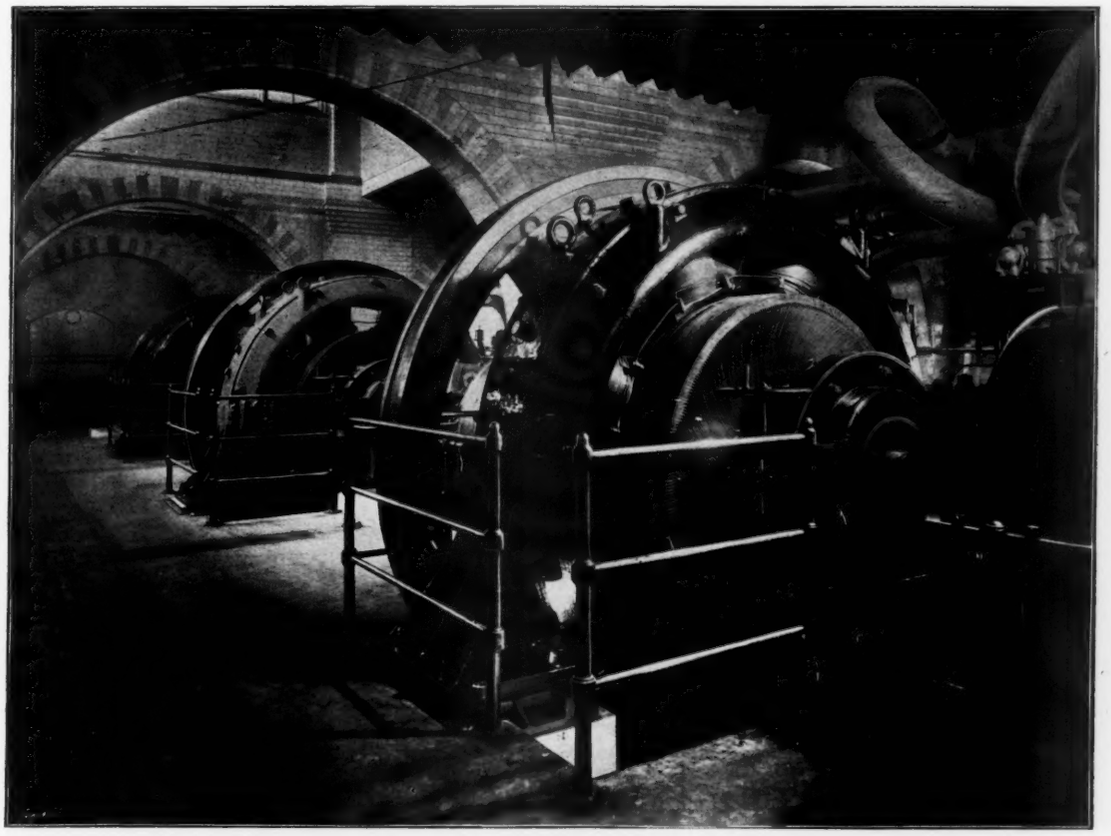
Holborn.—The Clerk of the Board of Works reports that, for the purposes of electric lighting, it is proposed by the Board of Trade to divide the district, one company to have the part south of Holborn, and the other the north part. A resolution was passed that the Board of Trade be informed that the Board of Works is still of opinion that both companies, who were now applying for permission, should be allowed to come into the district.

(*Continued on page* 549.)

ELECTRIC LIGHTING AND INSURANCE.

Probably one of the most important, if not the largest private electrical installation in the country, is one that has been recently completed at the offices of the Prudential Assurance Company by Messrs. Drake & Gorham, with Mr. J. Landon in charge of the works. Some idea of the magnitude of the plant will be gained from the illustrations and the following description.

The Prudential Assurance Company have, during the last few years, been extending their premises to a great extent; whole streets are being pulled down to make room for these extensions, which seem to be never ending. One is almost sorry to see such famous localities as Furnival's Inn rapidly disappearing, but the demands of life insurance seem to be inexorable.



General View of Dynamos at the Prudential Company's Offices.

The growth of the Prudential Assurance Company is probably one of the most remarkable features in the history of life insurance, and the alterations in the methods of lighting afford a faint indication of the increase in the business of this company.

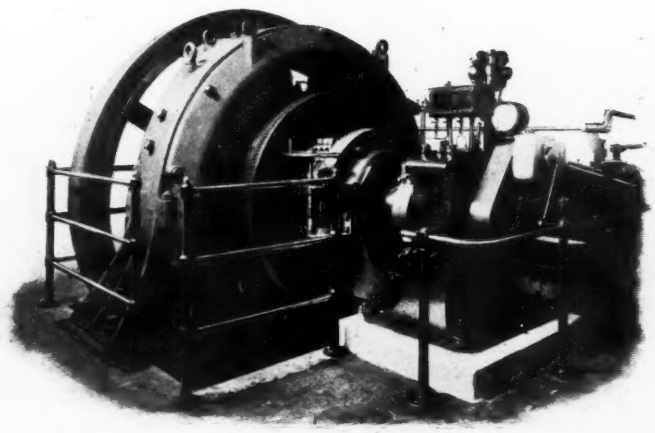
It has been necessary to entirely re-model the electric light installation which Messrs. Drake & Gorham originally designed, the old plant having worked without intermission for 10 years. The policy which has been found so successful in central station work of turning out less efficient machinery and replacing it with modern plant of higher efficiency has been adopted in the present instance; in fact, the whole of the apparatus is new from beginning to end. Messrs. Drake and Gorham, who have now completed the plant, have adopted slow speed dynamos, running direct between two horizontal coupled engines.

Each set consists of one dynamo and two single cylinder engines, weighing 60 tons, the weight on the main bearings being 22 tons. The dynamos have eight poles, the magnets being bolted to a steel ring 10 feet 5½ inches in diameter; the armature itself is 6 feet in diameter; the commutator has 360 segments, and is 3 feet in diameter, the revolutions being 85 per minute. A special pit is arranged beneath the commutator to enable the attendant to adjust the brushes. The weight of the armature and crankshaft is 15 tons, and there is a fly-wheel 12 feet in diameter, to ensure steadiness in running. There are three sets of this description, each of 184 kilowatts, and two smaller ones for light load.

The brush gear of the large dynamos is in some respects similar to that of the electric lighting dynamos employed by the Great Eastern Railway Company for lighting Liverpool Street and adjoining stations. There are 24 brushes arranged in eight groups of three brushes, the groups being alternatively positive and negative. The positive and negative groups are connected to copper rings carried in the main bearing of the armature. A hand-wheel and gear enables the position of the brushes to be readily altered as required, and gives a wide range of adjustment. Connection between the dynamos and the switchboard is made by means of rubber cables carried in earthenware pipes laid underground.

In accordance with the above proposal, engines to work up to 350 B.H.P. were specially constructed by Messrs. Marshall, Sons & Co. They are of the well-known coupled high pressure

type, with 18 inches cylinders × 36 inches stroke. The steam admission gear is of the Proell type, and the exhaust gear of the Corliss type. A central governor controls the automatic gear for each pair of engines. The smaller engines are of the vertical type, one having cylinder of 16 inches × 16 inches stroke, the other 12 inches cylinder × 14 inches stroke. The portions of the dynamo were obtained from Messrs. Crompton & Co., and erected by Messrs. Drake and Gorham *in situ*. This particular size and arrangement has proved so satisfactory, that similar steam dynamo plants have since been constructed. The steam is supplied by five Cornish multitubular boilers, 24 feet long and 7 feet 7 inches in diameter, supplied by Messrs. Marshall, Sons & Co.; they work at a pressure of 100 lbs. through a duplex 11-inch wrought-iron steam main. The exhaust steam is utilised for heating purposes in the building.



One of the Large Machines at the Prudential Company's Offices.

The original design of main conductors for the distribution of the current has proved to be so successful that it has been extended. This consists of bare copper strips suspended from insulators on the walls of the building outside the area. There are many tons of mains on the walls. In most cases they simply run from bottom to top, entering the building at each floor, so that the appearance is extremely neat. The main distributing board is fitted with Messrs. Drake and Gorham's patent spring contact switches and Kelvin measuring instruments.

The Light Load Plant at the Prudential Company's Offices.

Practically the board is divided into two, positive and negative. On the positive board are three main switches for the three large dynamos, with fuses and ammeters connected to the main omnibus bar. In addition, are 14 switches and fuses which control the circuits into which the system is divided.

The negative board contains the negative fuses of the 14 distributing circuits and the main negative fuses of the large machines. The ammeters, switches, and fuses of the two small dynamos are also on this board, as well as the discharge switch of the battery.

We have already mentioned that the distribution is effected by means of 14 circuits, each of which is arranged to carry 300 amperes or practically 500 lights. Tappings from the main conductors are made on each floor, and at this point a sub-distribution board is arranged which is provided with a double pole switch and double pole fuses.

In spite of the work of the Prudential Company being chiefly confined to the daytime, it is necessary to provide a supply for the complete 24 hours. The light load demand during working hours is met by the smaller machines, but the all night supply is furnished by a large battery of accumulators.

The accumulators manufactured by the D.P. Battery Company are of the new central station type, and have several novel features, one being that the active surfaces of the positive plates are arranged facing one another on the inside of the plate, thus exposing a very large surface to the negative. Although these plates are cast in one piece, they may be described as being built up of a number of narrow plates facing one another, with ample space for acid and electrolytic action between the whole, forming one plate. Now, in an ordinary plate for every inch in width there would be 9 inches exposed, this being the height of the plate, but here we have in the width of 1 inch three strips, each 1 inch deep, having, therefore, six times the surface exposed, or 54 square inches. This plate, patented by Messrs. Drake and Gorham, has been thoroughly tried by the D.P. Battery Company for the past two years, and machines are now being put down to deal with the large demand that has already arisen.

In order to enable the machines to be wound for 100 volts instead of 130, and to permit of the battery being charged from the omnibus bars, a booster has been erected which raises the charging current to the necessary charging volts. The switchboard specially set apart for the accumulators and the motor generators is furnished with double pole switches for charging the battery, *i.e.*, on the generator side of the booster, and on the motor side, in addition is a 500-ampere charge and discharge regulator. This board is, of course, only used

for charging, the discharge circuit being broken by a switch on the negative board.

The plant, with one set in reserve, is capable of dealing with 6,500 lights of 16-C.P. (equivalent to 13,000 8-C.P. lamps), a portion of which are fixed, and the remainder are being put in as the building proceeds.

The Boilers at the Prudential Company's Offices.

Owing to the steam being used for a pneumatic arrangement for sending messages from one part of the building to the other, for pumping, heating, and other purposes, it has been impossible to determine the actual figures as regards working cost, but the rough tests made have shown the result to be very satisfactory in every way.

The whole of the above work has been supervised on behalf of the Prudential Assurance Company by Mr. G. Bailey, of the Surveyors' Department.

Looking back upon the time when the Werdermann or Joel semi-incandescent lamp was first tried in the Prudential Offices, the present installation enables one to fully realise the progress which has been made during recent years in electric lighting, and Messrs. Drake & Gorham may be congratulated upon having erected a plant which for proportions and perfection cannot be surpassed in private supply. To Mr. Richardson, secretary to the company, high praise is also due for his indefatigable efforts to secure the best and most up-to-date arrangements for the colossal enterprise with which he has so long been associated, and with which he must feel eminently satisfied.

THE ELECTROLYTIC REFINING OF LEAD.

By SHERARD COWPER-COLES, M.I.E.E., A.M.I.C.E.

Lead, when recovered from its ores by smelting, is obtained as a crude metal, the so-called work lead, which has to go through a refining process in order to obtain soft or market lead. Work lead is obtained either by roasting reactions, by reduction, by roasting and reduction, or by the precipitation process. Refining is effected either by oxidation after fusion, or by electrolysis. Lead is never obtained pure when smelted from the ore. It is almost always alloyed with all the other metals contained in the ore itself. Apart from the fact that the useful properties of the metal are affected by these other metals, it is, of course, advisable for economic reasons to recover the precious metals present, such as silver One of the first processes worked on a commercial scale for the electrolytic refining of lead by electrolysis was that of Keith. In this process the crude or work lead is melted at the lowest possible temperature in iron kettles, from which it is tapped into moulds. The anodes thus produced are fastened to metal rods by suitable clamps, and enclosed in close-fitting bags of coarse muslin. The electrolysing cells are made of wood or iron; the cathodes are thin metal plates attached to rods in a similar manner to the cathodes. The electrolyte is composed of lead sulphate dissolved in an aqueous solution of acetate of sodium; it is made by electrolysing with lead anodes a mixture of $1\frac{1}{2}$ lbs. of acetate of sodium, $2\frac{3}{4}$ ounces of sulphuric acid, and 1 gallon of water, and is heated to 38° C. The sulphuric acid attacks and the acetate dissolves the lead, zinc, and iron of the anodes. The zinc and iron, being electro-positive to lead in the liquid, are less easily reduced to metal and accumulate in the solution, and when dissolved in considerable quantity are, to some extent, deposited as oxide on the cathode, the current density employed being about 1·86 amperes per square foot. The lead which is deposited on the cathode is crystalline in form and separates continually from the plates, a space being left in the cells for its accumulation. When the anodes have been dissolved, the bags suspended from their supporting rods are carried to a reservoir and the residual solid matter from the plates is washed and returned to the melting kettles. The slimes suspended from the wash water are allowed to settle, the water is drained off, and the residue filtered. The slimes usually contain antimony, arsenic, silver, copper, gold, and iron. A process that has been recently tried on a commercial scale is that of Tommasi. In this case, the electrolyte is the double acetate of lead and potassium (or sodium) the anodes are crude argantiferous lead, and two of these are opposed to a copper or aluminium alloy cathode, which is in the form of a disc rotating at the rate of from one to two revolutions per minute. These discs are about 10 feet in diameter and three-quarters of an inch thick and are half immersed in the liquid. At the upper part are scrapers which serve to detach the small spongy crystals of lead which form during electrolysis. The crystals when removed fall into channels which convey them to a sieve of wire gauze where they are drained and washed, the wash water being concentrated by evaporation to 20 Baume (sp. gr. 1·256) and used again in the electrolyte. The lead is then compressed and mixed

The Switchboard at the Prudential Company's Offices.

with 2 or 3 per cent. of charcoal powder and fused. The silver, with most of the arsenic and antimony, is separated at the anode, and is collected in trays to be fused subsequently with sodium nitrate and a little borax, by which the silver is separated from the arsenic and antimony.* The cost is estimated by the inventor at from 8 to 10 francs per ton of lead when steam power is used. When lead acetate is used as an electrolyte, the resistance is found to be lowered, which is probably due to the prevention of lead peroxide deposits upon the anodes, which must be at the expense of the organic substance itself, which becomes slowly and surely oxidised. The products of the oxidation of acetic acid are carbonic acid gas and water, which are of no intrinsic value. This being the case the acetic acid becomes an expensive electrolyte as it has to be constantly renewed. The lead peroxide formed at the anode is reduced by a portion of the organic acid to oxide, which then dissolves in the acid and becomes finally reduced to metallic lead at the cathode. The impurities present in the crude metal and the oxides on the face of the anodes are usually bad conductors of electricity, and, if they do not become detached from the anodes, they form an insulating coat over a large portion of the anode surface. The natural consequence of this is, that the current passes mainly through those parts of the plate that remain freely exposed, and so the current density becomes greatly increased at those portions, with the result that the anode is rapidly riddled with holes. The addition of fluid carbonic acid when mixed gradually with sulphuric acid and digested for some time at a temperature of from 50 to 100° C. easily converts it into cresole sulphuric acid, which is soluble in water, and is capable of forming soluble salts with lead. These salts have been successfully used for the deposition of lead.

Maxwell Lyte has suggested converting the lead into chloride and electrolysing it in the molten condition. Crude lead is fused and oxidised by a blast of air in a converter, the oxide is then stirred with hydrochloric acid in earthenware vessels until it is converted into chloride. Any silver compound associated with the lead, salt, or oxide treated, is chlorodised and is extracted from the mass by the application of strong hydrochloric acid or brine.

MEASUREMENT OF THE EFFICIENCY OF CONTINUOUS CURRENT ELECTRIC MACHINES OF ALL POWERS.†

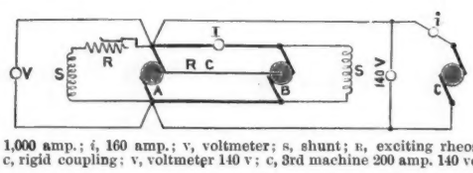
By P. DUPUY.

We know what difficulty is experienced in the workshops where electrical machines are constructed, in determining accurately the efficiency of these machines.

The brake methods are no longer employed, on account of their want of accuracy, and the different sources of error arising from their employment. Other well-known methods require mechanical appliances and rheostats, that are not often available when the power of the dynamos to be tried attains a certain importance. The method that we are about to describe has not yet been proposed, we believe, and we think that it may be of some interest to machine constructors.

This method necessitates the use of two similar machines.

The two dynamos, A and B, to be tried (fig. 1) are coupled



I = 1,000 amp.; i, 160 amp.; V, voltmeter; S, shunt; R, exciting rheostat; R C, rigid coupling; V, voltmeter 140 V; C, 3rd machine 200 amp. 140 volts.

in parallel by means of conductors of short length and considerable section, so that we need not take into account losses of energy from this cause. The two dynamos have their armatures coupled rigidly by any system, a Raffard coupling, for instance, and the connections are arranged as shown in fig. 1.

We send into the whole arrangement the current produced by a third dynamo, C, the power of which need not be equal to that of the two first.

We will suppose that we have to try two machines of 140,000 watts, at 140 volts; it will be sufficient, for instance, to have for the third machine a power of 28,000 watts, or 200 amperes, at 140 volts.

The rigid pair of machines to be tried begins to revolve; the excitation of one of them is then lessened, so as to break the electrical equilibrium existing before. Precisely at this moment, we must observe, one of the dynamos becomes a generator and the other a motor. The current resulting from this want of equilibrium is then made to give the normal output, or, in the case under consideration, 1,000 amperes. The two dynamos of 140,000 watts then work at their normal rate of 1,000 amperes at 140 volts, and it is evident that the losses are furnished by the third machine, and we have only to measure the output in amperes and in volts to get the total losses of the two dynamos. The total loss of one of the two dynamos being tested is equal to half the watts furnished by the third machine.

Working thus, we suppose that the efficiencies of the two machines are equal—which is not quite correct, as one of the machines is a generator and one a motor. This error, however, can be disregarded, as practically it only amounts to some thousandths, and, moreover, the hypothesis is used in other methods.

There is also, in this method, another source of error, which we will mention, although it is of scarcely any practical importance, especially in powerful machines.

In short, the watts furnished by the third machine representing the total loss, include the losses by the Joule effect, which should be expressed by $2\,R\,I^2$, and which are by

$$R\,(I - i)^2 + R\,(I + i)^2 = 2\,R\,I^2 + 2\,R\,i^2,$$

or an addition given by the term $2\,R\,i^2$. But we must observe that the resistance, R, is very weak in powerful machines, and that, moreover, this augmentative error is of an opposite nature to the one due to the above-mentioned cause, so that for both these reasons it is practically of no importance.

If we again take, as an example of the application of this method the two machines of 140 kilowatts, quoted above, we get, at the tension of 140 volts:

$$I = 1{,}000 \text{ amperes}$$
$$i = 160 \quad \text{,,}$$

which gives a loss of

$$\frac{160}{2} = 80 \text{ amperes}$$

for each machine, or an efficiency of

$$\frac{1{,}000 - 80}{1{,}000} = \cdot 92.$$

As we see, this method is particularly applicable to the practical testing of powerful units; it has the advantage of being quick, and it only requires a very limited apparatus, the various appliances being found in all testing rooms of machine constructors. We think, therefore, that this is a very practical method, and, as such, we have thought it would be worth while to make it known.

Interesting Ceremony.—An interesting gathering took place recently at St. James's Hall, Manchester, at which over 1,100 guests assembled to celebrate the silver wedding and at the same time the coming of age of the eldest son of Mr. and Mrs. Isidore Frankenburg. Mr. J. Furness, on behalf of the employés of the Greengate Rubber and Cable Works, presented a handsome epergne, suitably inscribed, to Mr. and Mrs. Frankenburg, and a dressing bag to Mr. Cherton Frankenburg. Among those present were Alderman Sir W. H. Bailey, Alderman Hall, and the Town Clerk of Salford. Alderman Sir W. H. Bailey added his congratulation in a neat speech. We also may, perhaps, be permitted to join in congratulations, as Mr. Frankenburg has recently entered the electrical field as a manufacturer of insulated cables.

* The arsenic and antimony are oxidised to the maximum and unite with the soda to form scoria.

† *L'Eclairage Electrique.*

ELECTRIC LIGHTING NOTES.

(*Continued from page* 544.)

Horsham.—Warnham Court, Mr. C. J. Lucas's country seat at Horsham, is to be lit with electric light. There will be 300 lights in all, which will be supplied from the farm by a combined system of gas and petroleum engines, the power being also utilised for pumping and driving farm machinery of all kinds. A "D.P." battery of 106 cells of the latest type will be provided. The contract has been entrusted to Messrs. Drake & Gorham.

King's Lynn.—Prof. Robinson's report on the electric lighting question is before the Council, and it has been decided to apply to the Local Government Board for sanction to a loan of £30,000.

Kinning Park.—A Kinning Park (Scotland) Municipal meeting referred back a recommendation to apply for an electric lighting order, and the Committee will obtain further information.

Leyton.—The tenders received for the electric lighting extension plant have been referred to the Electric Lighting Committee. For the dynamos, tenders were submitted as follows:—Electric Construction Company, £854; T. Parker, Limited, £931 10s.; General Electric Company, £647 16s. 6d.; United Ordnance and Engineering Company, £761; India-Rubber and Gutta-Percha Company, £738; Laurence Scott & Co., £771; Laing, Wharton & Down, £732; Brush Electrical Engineering Company, £827 7s.; Johnson and Phillips, £716 15s.; Siemens Bros., Limited, £737; Paterson and Cooper, £736. Contract No. 2:—Crossley Bros., Limited, £1,800; Wells Bros., £1,707 6s.; Bilbie, Hobson & Co., £1,803 2s. For buildings: J. Haydon, £2,643 4s. 9d.; F. J. Coxhead, £2,594 15s. Mr. Coxhead's tender was accepted. For switchboards: J. White, £181 12s. 9d; Bertram Thomas, £175 15s. 6d.; Laurence Scott and Co., £150; Laing, Wharton & Down, Limited, £157 10s.; Veritys, £153 4s. 9d.; Siemens Bros., £239 5s. Pea-nut anthracite is to be included in the next coal contract, and the grates of the present gas producing plant will be altered to suit the new fuel. From July 1st the charge for current for lighting purposes will be 5d. per unit for the first 1½ hours and 2d. per unit after, Wright's demand indicators being used.

London.—Mr. D. J. Ross, the City engineer, has issued a report on the works and improvements which have been executed in the City during the past year. He says that the number of arc lamps in lighting at the end of the year was 494. The question of lighting the side streets by electricity is still under consideration. The number of defective electric lamps observed during the last 12 months was 1,620. These returns are made to the Commission daily by the police, and the Electric Light Company is fined for each failure. Beneath the City streets now under the control of the Corporation, there exist at the present time about 2,360 yards, or one and a third miles of subway. The lengths of gas, water, and hydraulic mains, telegraph and pneumatic tubes, and electric lighting conduits laid in these subways amount to a total of 7½ miles. The electric light and telegraph conduits contain about 424 miles of wires and cables.

Lowestoft.—The provisional order has been approved and granted by the Board of Trade.

Ludlow.—The Public Lighting Committee reported that 10 schemes were sent in by engineers, and that of Mr. J. S. Enright, of Kensington, has been awarded the first prize of £20 by the Council.

Mexico.—Further copies of the Mexican papers show that several more failures have arisen in connection with the electricity supply plant. On one occasion recently a number of the public streets were in darkness the whole night, and the Portales, Municipal Palace, and other buildings were in darkness for a considerable time.

Newcastle.—At a meeting of the special committee of the Corporation, held on Monday, it was decided to submit to the Council a proposition in favour of approaching the electric lighting and current companies, with a view to buying up their interest and plant.

Paris.—The Municipality has decided upon having all the principal roadways of the Bois de Boulogne lighted electrically.

Perth.—Mr. Gripper, managing director of Edmundson's Electricity Corporation, Limited, has written to the Perth Electric Lighting Committee stating that as the provisional order would soon be passed, he should be glad to meet the Committee as to the transfer of the electric lighting powers to his company. The meeting resolved that the Committee were not yet ready to take any definite step in this matter.

Port Adelaide (Australia).—Early last month the Mayoress laid the foundation stone of the electricity works which are being put down by the South Australian Electric Light and Motive Power Company. The architect is Mr. W. W. Crawford, who has gone out from England under engagement to the company. The plant will consist of three boilers, a Green's patent fuel economiser, and four Belliss compound engines. These will be coupled to three Johnson & Phillips patent shunt-wound dynamos, each capable of giving an output of 70 amperes, 420 volts, at a speed of 350 revolutions per minute, and two dynamos of the same make, capable of an output of 70 amperes, 210 volts, at a speed of 420 revolutions per minute. There will, in addition, be the usual batteries and switchboards. It is estimated that the whole of the works in going order will cost £9,000. The contract provides for 23 arc lamps of 2,000-C.P. each, and 66 incandescent lamps of 50-C.P. each. The arc lamps will be turned off at midnight, and incandescents kept alight till sunrise. The contract is for 10 years; but at the expiration of five years the Corporation may acquire the lighting plant at a valuation.

Portsmouth.—A contemporary says that the Town Council will shortly consider a report for the lighting of the ordinary street lamps with electricity at precisely the same cost as is now incurred with gas.

Sheffield.—The Town Council held a special meeting the other day, and passed a resolution approving of the Council promoting a local and personal Bill in the present Session of Parliament to confirm the agreement for the purchase of the undertaking of the Sheffield Electric Light and Power Company, and to confer borrowing and other powers on the Corporation.

Shoreditch.—The report made by Messrs. Kincaid, Waller & Manville to the Electric Lighting Committee of the Shoreditch Vestry was discussed at considerable length at the Vestry meeting held on Tuesday evening. The consulting engineers recommended the Vestry to instruct them to prepare detailed plans and specifications for the alteration of the destructor house and the erection of new coal and accumulator house, and for the boilers and requisite steam and feed pipe connections and necessary accessories; and also to furnish a further report on the terms as to which the makers would be prepared to increase the size of the battery. The cost of the work was estimated by the consulting engineers at £13,200, which included a provision of 10 per cent. for contingencies and extras. Having been advised on the matter by the chief engineer (Mr. Russell), the Lighting Committee recommended the Vestry to generally adopt the scheme proposed, and that it should be referred to the Committee to advertise for tenders for the work. An amendment was moved and seconded that pending the making up of the accounts, the report should be referred back to the Committee. Replying to criticisms made upon the report and electric light station, Mr. Kershaw, chairman of the Lighting Committee, stated that during the third quarter the whole scheme of electric lighting had resulted in a profit of £1,700. With regard to the thermal storage plant, that had not yet had a practical test, but if the terms of the specification were not fulfilled the contractors would not be paid. They were, however, now treating at the rate of from 30,000 to 40,000 tons of refuse per annum, and it was believed they would have the lowest works' costs in London, and perhaps less than those of the Leeds works, where coal only cost from 6s. to 7s. per ton. It was proposed to put down five dry back boilers to supply steam to the engines ordered some time ago, and this would enable the present output of 407 kilowatts out of a possible 456 kilowatts to be considerably increased. Only six members voted for the amendment, which was lost, and the original motion was carried. The Vestry authorised the Lighting Committee to order from the Electric Construction Company a 30-kilowatt transformer and four switchboard panels for the arc light system. The Lighting Committee reported having received an inquiry from the Electric Vehicles Syndicate, asking for a supply of current at 1½d. per unit during the day. The Vestry resolved to inform the Syndicate that the offer made was not acceptable, but that they would be prepared to consider a proposal on lines similar to the terms made with the London Electric Cab Company. Fifteen tenders were received for the supply of arc lamps in connection with the extension scheme. These were referred to the Lighting Committee.

Southampton.—At the last meeting of the Town Council the Electric Lighting Committee submitted a report, showing that the number of units metered at the works during March was 19,186, being an increase of 42·5 per cent. over the number for March, 1897. Having considered an application from a corporate committee with respect to lighting the public parks, the Committee had resolved to defer the consideration of the matter until the question of public lighting was somewhat further advanced. The electrical engineer reported to the committee that he had been in communication with several firms upon the matter of electric lanterns for the police, but, having regard to the cost, weight, and other circumstances connected with the samples submitted for his inspection, he could not recommend them to the committee. The committee's report was adopted.

Southport.—At a recent Council meeting, the Gas Committee opposed a proposal made by the Electricity Committee to add 42 arc lamps to the street lighting, and the motion was eventually withdrawn.

Southsea.—A Committee is to consider the desirability of lighting St. Jude's Church, Southsea, with electricity.

Stockport.—The Local Government Board has granted the application of the Council for a loan (£24,600) for electric lighting purposes, and has approved of the land lately occupied by the Millgate gas works as a suitable site for electricity works.

St. Pancras.—At last week's Vestry meeting, Mr. Thornley submitted a special return, showing that a beginning had been made at the destructor in generating electricity from dust. The committee hoped to bring up a more complete return on a future day. They had already generated some hundreds of units.

Sunderland.—The Town Council has adopted a report recently submitted by Mr. Snell, the borough electrical engineer, on the subject of electric lighting extensions. Application will in consequence be made to the Local Government Board to sanction a further loan of £26,000 to carry out the scheme, and subject to such sanction leave has been granted to borrow £10,000 for immediate requirements. Mr. Snell is drawing up specifications, and inviting tenders for two Lancashire or Galloway boilers, and all piping and

accessories, one new Weir's pump, one new steam dynamo, complete with piping, &c., and two motor transformers. Mr. Snell has been also authorised to take steps so that the change to the 440-volt system may be effected in the spring of 1899, subject to the approval of the Board of Trade. In the report referred to the figures were given showing the increased demand which had rendered extensions necessary:—

Year ending.	No. of consumers.	8-C.P. lamps fixed.	Increase.	Max. load E.H.P.	Increase.	Capacity of station, E.H.P.	Capacity E.H.P. deducting stand-by.
Dec. 31st, 1896	113	11,289	—	294	—	345	210
Dec. 31st, 1897	170	19,177	7,888	499	205	480	345
Dec. 31st, 1898 (E)	—	23,750	4,573	630	131	715	480

To the present date the number of lamps connected has increased to 20,411, as against 19,177 in December last, or an increase of 1,234 in two months, to which must be added some 800 more applied for. The number of consumers has also increased from 170 to 191. The following table was also given:—

Year.	Electric H.P. required.	Total units estimated to be sold.	Estimated total capital outlay to end of year.	Working and sleeping costs.	Sinking fund and interest.	Total costs.	Revenue.	Net profit for year.
1898-9	630	418,550	£46,300	£3,580	£2,370	£5,950	£6,055	£105
1899 1900	800	529,470	£56,000	£3,860	£3,180	£7,040	£7,800	£760
1900-1	1,000	660,960	£69,000	£4,960	£3,700	£8,060	£9,430	£1,370

The estimate for all requirements to the end of 1901 is £12,728, but for immediate requirements the outlay will be £7,800. The report under the heading of "mains" says:—"The alternating plant is gradually being loaded up, and I expect will be loaded up by the year 1900. Instead then of adding to this plant, I propose to serve that district by direct current, and to lay a feeder (in the existing conduits which convey the high tension cable) to, say, the corner of Belvedere and Stockton Roads, looping up the now isolated pieces of distributing mains; a much more reliable, safer, and more economical system will thus be provided; a 24 hours' supply given with economy to all consumers, residents, and others alike, and the whole supply will be derived from one system instead of two. It must be distinctly understood that I do not propose to do this yet; but I shall require your sanction to this scheme to enable me to pave the way gradually for the change. I am confident, after the most careful and lengthy consideration of the matter, that this will be the best system for Sunderland, both immediately and when considering the future. The alternating plant could still be made use of for pioneering another district, [*e.g.*, Roker, until such time as that outside system had grown to such extent as to warrant its transference to the general system. It may be necessary, when effecting this change (unless some arrangement is arrived at between the Corporation and consumers), to change the lamps in most of the consumers' premises, and to effect some minor alterations therein. The cost will not be large, compared with the very great advantages otherwise obtained. I wish to point out that the present mains will carry from three to four times the amount of energy without increase of section by this method, and therefore a very great saving will thus be effected. Estimate:—Extensions of feeders in present district, *required at once*, £675; mains to the workhouse, £2,200; new feeder to residential district, £1,665; three years' ordinary extensions of mains and services, meters, &c., £7,000; allowance for new lamps and alterations to consumers' wiring in certain cases, £1,000; total, £12,540."

Taunton.—The Taunton District Council long ago made itself conspicuous for its debates on electric lighting, and that reputation it has maintained up to the present time. No fair-minded man would wish to prevent legitimate discussion on the electric lighting question in any council chamber, but in some parts of the country there is a tendency among councillors to take every opportunity of finding fault with either the electricity works or the administrators thereof. There has been considerable heckling at Taunton from time to time, and one member in particular has been very much in evidence in the debates. Where the desire to oppose exists it is not unusual that actual facts should be ignored and gross mis-statements made. And it may often happen that these mis-statements will do a considerable amount of harm unless they are publicly contradicted. At Taunton it seems that the mis-statements have been so gross and so often repeated that the Electric Lighting Committee has felt itself compelled to give a quietus to two councillors who have circulated them. That body has, therefore, drawn up and issued to the local public a lengthy explanation, showing on the one side the mis-statements of Messrs. Standfast and Clement Smith, and showing, on the other side, item for item, the actual facts. The document is duly signed by the 10 members of the Electric Lighting Committee. A comparision of the facts and the mis-statements, allowing the necessary grain of salt on either side, is evidence of the extent to which public men can go in trying to prove their case. The matter is not of more than passing interest, though we suppose the issuing of this statement may lead to further protracted discussion both in the local press and in the council chamber, but borough electrical engineers and sometimes electric lighting committees in different parts of the land have to listen to most absurd statements from ignorant councillors, and though in most cases the statements are only worthy of contempt, there is yet such a thing as going too far. Then is the time to meet the matter in the way adopted by the Taunton Committee. It ought to have a healthy effect upon the Council generally.

Councillor Standfast has issued a circular in reply, in which he proves to his own satisfaction the inaccuracy of the Committee's statements.

Wallasey.—A Local Government Board inquiry was held on 14th inst. into the Council's application for a loan of £20,785 for electric lighting extensions. The sum is made up of £17,725 for electric lighting extensions proper, and £3,060 for purposes of street and promenade arc lighting. The amount of £17,725 is required to extend the engine and generating power, and to supply 150 more consumers. The sum of £3,060 is composed of £1,380 intended to be spent on 46 arc lamps and standards for the streets, and £1,680 for 16 arc lamps for the promenade, together with the necessary cables and attachments. The electric light was installed in the district and first used in the month of January, 1897. There were then 2,000 8-C.P. lamps in connection with the supply, but at present the number is between 5,000 and 6,000. The number of consumers is about 100. The profit for the 11 months ending March last was £840. Applications for energy were being received so fast that the committee were unable to comply with them owing to insufficient generating power. Since the system was installed the price had been reduced from 7d. to 6d. per Board of Trade unit, and a reduction had also been made for prolonged consumption. Evidence in support of the application was given by Mr. J. H. Crowther, lighting engineer.

West Ham.—The West Ham Board of Guardians has been considering the question of improved lighting of the Workhouse, and it was thought advisable to consult an engineer *re* laying down electric lighting plant. The Leyton District Council offered to supply current at 3d. per unit. The matter stands adjourned for a fortnight.

In the Corporation Bill power is sought to amend the provisions of the West Ham Electric Lighting Order, 1892, with reference to power to supply and let electric fittings.

Weston-super-Mare.—The Municipal Electric Supply Company, having offered to take over the Council's electric lighting order, the Council has written stating that, if it determines at any future time to dispose of its order, the company's terms shall be considered.

Winchester.—The Winchester Electric Light and Power Company has written to the City Council on the subject of street lighting. The present lighting contract terminates in a few months, and as a special arrangement was made for supply of current for all municipal purposes at 4d. per unit, the company has raised the question. The works are now about ready to supply current. We understand that tenders are being invited for lighting the streets for three or five years.

Wycombe.—The foundation stone of the electricity works was laid by the chairman of the Electric Lighting Committee last Saturday.

Yarmouth.—The new plant referred to last week comprises a 150-kw. steam alternator. Mr. Ranken, in his report recently, stated that the number of lamps connected has during the last two years been increasing at the rate of about 2,500 lamps per annum. Taking this figure as likely to continue during the next 18 months, he estimated that the number of lamps connected will, in September, 1899, be about 14,700, increased to 15,300 if the Council carried out the illumination of the Drive by festoons of coloured glow lamps. Towards the end of the season 65 per cent. of the lamps are in use at one time, so that before the 1899 season it will be necessary to provide enough machinery to supply 10,000 lamps alight simultaneously, with sufficient reserve plant. The new plant will enable the works to supply 12,000 lamps at one time, leaving one 150-kilowatt set in reserve. No addition to the boilers will be required until it was necessary to increase the engine room plant, which, at the present rate of growth, would not be till 1901. It would be advisable to order this plant not later than June next, as most of the manufacturers have so much work in hand, that they will require a year to execute the contract. The Council resolved to apply to the Local Government Board for sanction to a further loan of £4,800, and that Mr. Preece be consulting engineer for the new engine and alternator. The items in the application would be as follows:—Steam engine, 1,500 kw., alternator and steam pipes, £2,800; additional high and low tension mains, £1,600; transformers and transformer stations, £400; total, £4,800. The quarterly electric light statement showed that the receipts totalled £1,203 5s, leaving a margin of £564 2s. 9d. over the cost of production, which is sufficient to pay all capital charges, interest, and sundries. The accounts for the nine months ending December 31st showed that the income had met expenditure, including repayment of capital, within £327. Out of capital repayments during the year of £852, the surplus revenue from the light had paid £525.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Ayr.—There was a brief discussion at last week's Council meeting regarding electric traction, a proposal to put down overhead trolley lines having been submitted by Mr. Bickerdyke, of Montreal.

Bradford.—The deputation which went to the Continent early in March to inspect electric traction systems with reference to the supply of electricity for electric lighting and electric traction purposes from the same plant, has issued its report. The deputation consisted of the Mayor, Councillors Dixon and Shaw, and Mr. Gibbings (borough electrical engineer), and paid visits to Brussels, Hamburg, Berlin, Dresden and Leipzig. After taking into consideration all that the deputation saw they express themselves satisfied that the arrangements already made at the Valley Road electricity works for running the Bolton Road and Great Horton tramways, are as complete as anything seen on the Continent, but the Continental generating stations are very much larger and finer than anything in this country. Instead of making undue haste in the matter of electric traction or lighting the committee says that we are considerably behind the development which has already taken place in each of the towns visited. It appears to be the practice to utilise either the accumulator system or the conduit system for crossing the more important thoroughfares in the centre of the town with electric trams, "thus doing away not only with the unsightliness but possible danger of the overhead wires," and although the initial cost of the conduit system is considerably higher than that of the overhead, it was found to be far preferable in the centre of the cities visited.

Bristol.—Pursuant to the instruction of the Bristol City Council, the Tramway Committee of that body have taken steps to continue, or rather to re-open, negotiations with the Bristol Tramway Company with regard to the extension of their system and the adoption of electric traction. One of the points upon which a deadlock had occurred was as to the period at which the new lines should be purchasable by the city. The committee desired they should be purchasable at the same time as the old horse lines, in other words, about 14 years hence. The company stuck out for the full 21 years allowed by the Tramway Act. An intimation had been since given that the company were prepared to throw their various lines together and to give the city power to purchase the whole in 18 years. The Bristol city engineer has calculated what the period would be on simple mathematical lines and finds it works out to 16 years and 7 months. Thereupon the committee suggested the term should be 16 years 6 months, so that 18 months only separated them from the company upon this point of the negotiations. The company's representatives asked for an interview with a deputation from the committee, and on Monday the Sanitary Committee commissioned their chairman (Alderman Cope Proctor) and vice-chairman (Mr. George Pearson, who happens to be chairman of the civic electrical department) to meet the company's nominees and talk over the whole subject. The citizens, the great majority of whom are anxious electric traction should not be delayed, are now hopeful that terms will still be arrived at.

The Kingswood Council has been informed by the Light Railway Commissioners that they propose issuing the order applied for by the Bristol Tramways Company to authorise the construction of a new line from St. George to Hanham. The Council was asked to make any suggestions thought necessary.

Cable Traction.—It is interesting to note that Messrs. Dick, Kerr & Co., have just secured a contract for the equipment of cable tramways at Edinburgh for the sum of £89,000.

Christchurch and Poole.—The Pokesdown District Council has resolved to grant the representatives of the British Electric Traction Company an interview in order to discuss their new scheme of a light railway from Christchurch to Poole.

City and South London.—An evening paper says that the contract for the construction of the extension of the City and South London Railway from Stockwell to Clapham Common has been placed. This extension is to be completed in 15 months.

Cork.—The electric tramway and lighting plant and undertaking, which was commenced last November, is said to be approaching completion. It is expected that the lighting will be in operation by the end of May, and the tramways before July 1st. Orders are being booked for lighting current. There is a local free wiring company. The chief engineer of the undertaking is Mr. Horace F. Parshall, and Mr. Wright, of Brighton, is stated to be in charge of the lighting arrangements at Cork. Mr. Richard D. Walsh, C.E., of Dublin, is the engineer for the tramway construction, and Mr. Merz and Mr. Beverley Griffin are the resident engineers for the electric works and tramway construction respectively.

Coventry.—The work of extending the electric tramway system is being rapidly carried out in Coventry. The extension is nearly six miles in length, and will open up communication with the outlying districts. The existing line, which has been successfully working for several years, connects Coventry with Bedworth, a distance of about seven miles.

Dublin.—Before the Judicial Committee of the Privy Council, sitting at Dublin Castle last Saturday, application was made by the Dublin United Tramways Company for an order in Council to authorise the construction and extension of several tramways in the County of Dublin, in the Townships of Rathmines and Rathgar, Pembroke, Drumcondra, Clonliffe, and Glasnevin, and Clontarf, in the City of Dublin. The matter was adjourned for four or five weeks. The Dublin Corporation had the previous day passed a resolution approving of the scheme conditionally.

Liverpool.—The Corporation Tramways Committee on Friday last inspected specimens of an American-made, and of a German-made, electric car for the new experimental electric line to the Dingle, and they have decided to order a number of cars of each make.

Leeds.—The Tramways Committee is to purchase 10 additional trailer cars.

New Conduit System.—A model car and tramway on the Munson electric conduit system has been fitted up at the Glasgow Corporation Tramways works, in St. James Street, by the Munson Electric Conduit Company, of Chicago. There was a press inspection on 15th inst. Mr. Wm. Arnot, late electrical engineer to the Corporation, explained the working of the system. The system is described in the Glasgow papers as follows:—"Within the conduit, placed at intervals regulated by the length of the car, are small gun-metal rollers. These rollers are fixed on the end of a plunger, to the other end of which there is attached a tongue, which is in metallic connection with the roller. Opposite the tongue are two contacts connected with the main wire, which is equivalent to the trolley wire on an overhead system. This main wire is laid in solid insulating material, such as hard bitumen. Opposite the roller is a second one connected similarly, and having the main return wire on the other side. The action that takes place while a car is running is that, when the plough which protrudes underneath the car comes between the two rollers it forces them inwards, the tongue on the end of the plunger in both cases going in between the two contacts which are connected with the main cables, and completing the circuit, the motor is actuated in the usual way. Whenever the car leaves these two rollers they are forced out, and then become quite dead—that is to say, no electricity is in them. The plough of the car, before leaving one pair of rollers, makes contact with the pair in front. The great point claimed for the system is, that the entire system is an insulated one on both sides, that the return current is not taken back by the rails, hence there can be no trouble with the electrolysis, and that no bonding of the rails is required."

Paisley.—At a meeting of the Town Council on the 12th inst., it was stated in the minutes of Council that at a recent committee meeting Mr. Emile Garcke, manager of the British Electric Traction Company, Limited, was introduced and heard with reference to the proposed construction of electric tramways in the burgh and as to the probable requirements of the company for supply of motive power from the Corporation works. After a lengthened statement, he asked that the Council should agree to the principle on which the proposals of the company are based, subject to the terms of the provisional order to be obtained by the company, and the system they propose to adopt, being satisfactory. Mr. Garcke having retired, the clerk read letters from the Simplex Electric Tramway Conduit Syndicate, Limited, and from Mr. R. Bickerdyke, vice-president of the Banque d'Hochelaga, Montreal, calling attention to the merits respectively of the "Simplex" and "American Electric Trolley" systems of electric traction. These he was directed to hand to Mr. Teague, and it was agreed to defer consideration of these and of Mr. Garcke's proposals until Mr. Teague has reported in terms of instructions.

The Electric Power Schemes.—The Clerk to the Derbyshire County Council has informed the Blackwell District Council that the General Electrical Power Distributing Company has decided to put certain clauses into its Bill that would meet a good deal of the opposition now directed against it by various public authorities. The introduction of these clauses would practically wipe out the Blackwell opposition.

As there has been so much opposition raised to the scheme of the General Power Distributing Company, the *Derbyshire Times* discusses the advantages of the scheme at some length.

Roumania.—The Helios Company of Ehrenfeld, Cologne, is reported to have secured a contract for the construction of an electric tramway in the town of Braila, Roumania.

Sheffield.—The question of site for the electric tramway power station is occupying attention at the present moment. Various sites have been suggested, and various opinions are held as to their suitability. The Tramways Committee recommended, and the Council approved, of the Kelham Island site, and Mr. H. F. Parshall, of the British Thomson-Houston Company, expressed the opinion that this was in all ways suited for the purpose. Dr. Hopkinson in his report discussed the respective advantages of half-a-dozen sites, and we abstract a few of his remarks:—"Kelham Island is in reality less advantageous in position than would appear at first sight, because it will not be convenient to lead out conductors in the most direct way for the supply of the district to the north-west and west. The conductors for this direction must be brought back to Alma Street, and part of them as far back probably as the Borough Bridge. The station further is actually at a greater distance from the centre of the district than any one of the remaining four. Water for condensation is, of course, readily obtained, but the whole of the coal required would have to be brought in by cart. . . . Johnson Street is favourably situated in regard to the work to be done. Comparing it with Kelham Island, it is a little more central; it is equally advantageous with regard to condensation, and it may be better placed for bringing in coal if the overhead gantry can be carried out. . . . Assuming that the foundations were all good, and not requiring piling, I should on the whole prefer Johnson Street. But the advantage of one over the other is not so great that it would be worth while going into any very large expenditure in purchasing one site rather than another. A perfectly successful result should be obtained with any one. It has further been suggested to me that the tramway generating plant might be placed on a part of the land occupied by the present electric lighting station. The station is well situated in relation to the work to be done, and I understand there is water for condensation. There is also sufficient room in the

existing buildings for enough machinery for present requirements. I see no objection to the plant immediately required being placed there, and to leaving the question of where a larger plant shall be fixed to be settled later."

Sunderland.—The Council has decided to send a deputation consisting of the Mayor, Tramways chairman and vice-chairman, borough engineer, and the borough electrical engineer (Mr. J. F. C. Snell) to the Continent, to obtain information respecting electric traction.

West Derbyshire Light Railway.—At a meeting of the Derbyshire County Council last week it was reported that the promoters desired to increase the width of the gauge from 4 feet to 4 feet 8½ inches. The Council decided to raise no objections, on certain conditions, among them being:—That no steam power shall be used on the line; that the length of the trains shall be restricted to two carriages, in addition to the carriage carrying the motor power.

Whitley.—A poll was taken on Saturday of the parochial electors and ratepayers of the urban district of Whitley and Monkseaton, to ascertain the feeling with regard to the proposed introduction of electric tramways. The result of the ballot was: For the tramways, 260; against, 220; majority for, 40.

TELEGRAPH AND TELEPHONE NOTES.

Australian Overland Lines.—It appears, says the *Financial News*, that the South Australian Government has decided upon the desirability of duplicating the overland telegraph by the erection of a second wire to Port Darwin. The subject has claimed attention as a result of the recent interruptions in the existing wire, and the complaints they have entailed. The double wire, when the intended addition is completed, will have a working capacity nearly four times greater than the existing single one, and this will greatly facilitate the transmission of messages and prevent a block on the line. The cable company has two cables to Port Darwin, and, as South Australia has only one wire, the cable has at present an advantage over the land line. There are over 2,000 miles to be traversed, and it is expected that the work will be completed about the end of the year. The total cost is estimated at something over £50,000. The Agent-General in London has been advised of the materials required for the work, and is now only awaiting the receipt of a cablegram to put the order in hand.

The Cuban Crisis.—It is stated that the Minister of the Colonies for Spain has approved of a contract for the laying of a telegraph cable between Cadiz and Havana *viâ* Teneriffe and Vieques, an island near Puerto Rico.

Delays in Australian Telegrams.—We reprint an extract from the *Sydney Morning Herald* of the 12th ult., which shows that the Australian public is perfectly alive to the inconvenience caused by the very frequent interruptions to the Australian landlines. We believe that the South Australian Government propose to remedy this very unsatisfactory state of affairs by putting another wire on the same poles as the present line from Adelaide to Port Darwin is carried upon. It is estimated that this proceeding will cost something over £50,000, but it seems absurd to expect that by putting additional weight on these poles they will stand any better than they do at present. It has been stated in the House of Commons that the Colonies are making no movement in favour of a cable across the Pacific, but it is difficult to understand how the public can do more than protest in the press, and how the Premiers of the Colonies can express themselves more strongly than they have done at the recent Federation Conference, where it was agreed, with regard to the Pacific cable, "That if Great Britain and Canada would contribute each one-third of the cost, the four eastern Colonies, Queensland, New South Wales, Victoria, and Tasmania, would favourably consider the proposal to provide the remaining one-third of the contribution." As regards the official notification of the delays in Australian telegrams, a correspondent in the *Sydney Daily Telegraph* writes concerning the telegraphic department of South Australia, which, he says, "sends to the Sydney office the most misleading information regarding the state of cable business. To go no further back than yesterday, the official notice read as follows:—'London, 8.28 p.m., March 2nd. Received Adelaide 7.7 a.m., March 3rd, equal to 8 7 a.m. Sydney.' Whilst the actual experience of business people was:—'London, 6.50 p.m., March 2nd. Received Sydney Telegraph Office 5.40 p.m., 3rd idem (after business hours)' or a difference of no less than 11 hours 11 minutes between official representation and actual facts, whilst for business purposes the difference was equal to 24 hours."

The extract above referred to from *Sydney Morning Herald* runs as follows (we would merely premise that "Broome" is identical with Roebuck Bay):—

"Cable Communication.

"*A Series of Interruptions. The Record since January.*

"The imperfections of the present means of communication between Australia and Europe have been the cause of increasing dissatisfaction among commercial classes. Local feeling on the subject was expressed on Thursday by the deputation (from the Sydney Chamber of Commerce) that waited on the Postmaster-General; and although it cannot be said that that deputation exhausted the possibilities of the subject, it brought the question into prominence, and gave the movement towards reform an impetus that it much needed. The main object of the deputation was to advocate the claims of the Pacific cable. A more general question, and one in which all sections of the public are directly interested, is that which is concerned with the reasons for the interruptions, their increasing frequency, and the possibility of an improvement in the present state of affairs. That there has been more trouble with the cable service of late than was the case formerly Mr. Cook admitted. As a well-known merchant said to a *Herald* representative yesterday, messages are delayed, and it is impossible for the person who receives them to be certain how long the delay has continued. He is unable to say whether the message was put in half an hour, an hour, or 10 hours ago. To the commercial world a doubt of this kind is often attended with serious consequences. The uncertainty is, in fact, the worst feature of the case.

"Speaking generally, it may be said that the interruptions which have occurred during the past few months have occurred on the overland service. There are practically two overland lines connecting Sydney with Europe. The bulk of the work falls upon the line between Port Darwin and Adelaide. This is the principal medium for transmission of English and Continental intelligence. There is another line which crosses the south of the continent and connects Broome in the west with Port Adelaide in the south. This line serves as a sort of second string for the line running north and south, but it is in an almost chronic state of disrepair. As far as the lines between Adelaide, Melbourne, and Sydney are concerned, there is seldom any difficulty. Occasionally, as happened two or three weeks ago, heavy rains and swollen rivers may delay communication for a day or two. But the question practically narrows itself down to the condition of the line between Adelaide and Port Darwin and that between Adelaide and Broome. It is these two which transmit foreign intelligence to the more central colonies, and it is with their efficiency, or otherwise, that the public are chiefly concerned.

"Probably only those immediately interested are aware how numerous of late have been the interruptions to the overland telegraph service. Occasionally something is heard of a deep-sea cable going wrong, but, taking the period from the present time back to the beginning of the year, it may be said that the difficulty has been entirely with the overland route. In the press, the heading 'Telegraph Interruption' has appeared with monotonous frequency. On Thursday last it was announced that the 'Port Darwin line is unworkable, and cables are being transmitted *viâ* Broome.' On the Tuesday previous, March 8th, the announcement appeared that the Port Darwin line was interrupted between Katherine and Port Darwin. On March 7th the familiar heading was again in evidence, and this time it was the Broome line that was out of order. On March 2nd there was an interruption on the Port Darwin line. On February 26th the *Herald* explained that there was no English news of the previous day, as the Port Darwin circuit was affected. An announcement of February 11th stated that the Port Darwin line was interrupted north of Woodnadatta. On February 9th came the news of another interruption to the same line; and going back to February 2nd there is still another, this time the news being accompanied by the additional intelligence that the line between Perth and Roebuck was working badly. On January 31st over 200 poles were down on the line between Overland Corner and Renmark. On January 24th an expedition had to be sent from Port Darwin to enable communication to be restored. On January 13th European messages were delayed through an interruption to some part of the overland line. In all 13 interruptions—some of them trifling, some were serious—have occurred on the overland line during the beginning of the year. The numbers are taken from announcements made in the columns of the *Sydney Morning Herald*. No official record has been kept locally, and it is possible that no mention has been made of interruptions of the more trifling kind. But enough has been said, however, to show that the representations of Thursday's deputation were well founded.

"As has already been announced, the South Australian Government has undertaken the continuation of a duplicate line between Port Darwin and Adelaide. The line will, however, for the most part be worked upon the same telegraph poles as those which support the present one, and for this reason the scheme is not received with much favour by commercial men in Sydney. Mr. H. C. Mitchell, secretary to the Chamber of Commerce, said yesterday that he was confident that nothing but the construction of the Pacific cable would satisfy local requirements. The convenience would be very great, and the saving would, he thought, be enormous. The Eastern Extension Company, while offering to lay a line from Natal to Port Darwin, made no offer to reduce the cable rates. The proposed Pacific cable would convey messages at a rate cheaper by 1s. 9d. a word than that at present in force. 'In five years' time,' said Mr. Mitchell, 'there will be four million words passing annually between here and Europe. A saving of 1s. 9d. a word means a saving on that of £360,000 a year. If the work is to be done, it should be done by the Government. The overland line may be interrupted, and the proposal of the Eastern Extension Company does not seem satisfactory. The Pacific cable would pass through British territory, and would be the cheapest in the end."

Interruption to Cape Cables.—During the present month two of the cables which form part of the main line from England to the Cape along the West Coast of Africa have been interrupted. The cable which connects Sierra Leone with Accra was interrupted on the 9th and was restored last Tuesday (19th). Another cable, which runs from Mossamedes to Cape Town was interrupted on the 14th and is not yet repaired. Thus, since the 9th of this month we have been depending for communication with the Cape on the cables along the East Coast from Aden; of which only the Mozambique-Zanzibar section is duplicated. The frequency of the interruptions to the Cape cables emphasises the necessity for laying the proposed alternative line *viâ* St. Helena and Ascension. In addition to the above we learn that another cable on the West Coast, *i.e.*, that from Mossamedes to Benguela, broke down on Wednesday.

The Privacy of Telegrams.—In reference to the order recently issued to the staffs at the various Post Offices on this very important subject, a correspondent of the *Standard* asks, What is the use of this order, when the contents of telegrams are telephoned from sub-offices to the Central Telegraph Offices in such a way that anybody in the sub-office can hear the whole contents of the telegram, together with the names of the addressee and sender? The other day he had occasion to send a telegram, and some question arising respecting it, he was catechised across the public office (then full of people) by the clerk in communication with the telegraph room. What made the circumstance the more annoying was that the message was perfectly in order. But at the busiest hour of the day the receipt of telegrams at a "first-class" provincial office was left to the care of one girl.

The Telegraph Wire Export Trade.—Quite an active trade was done in the exports of telegraph wire and apparatus connected therewith during the past month, the total value of the shipments amounting to £135,583, as compared with only £75,276 in February last, and against £139,642 in March, 1897. The total value of the exports for the first three months of the year may be considered satisfactory as it amounts to £248,788 as compared with £245,472 in the same period of last year, and only £188,302 in the first quarter of 1896.

Telegraphic Interruptions and Repairs:—

Cables.	Down.	Repaired.
Brest-St. Pierre (Anglo, 1869)	April 6th, 1893 ...	...
West Indies—		
St. Croix-Trinidad ...	Nov. 30th, 1896 ...	...
Cayenne-Pinheiro ...	March 24th, 1898 ...	...
Amazon Company's cable—		
Parintins-Itacatiara ...	May 5th, 1896 ...	...
Obidos-Parintins ...	Dec. 7th, 1896 ...	...
Cable beyond Gurupa ...	April 4th, 1898 ...	
Cyprus-Latakia	Feb. 10th, 1898 ...	...
Sierra Leone-Accra	April 9th, 1898 ...	April 19th, 1898
Bolama-Bissao	„ 12th, 1898 ...	...
Cape Town-Mossamedes ...	„ 14th, 1898 ...	...
Maranham-Para	„ 17th, 1898 ...	...
Landlines.		
Trans-Continental line beyond Masol	March 12th, 1898 ..	...
Cartagena-Barranquilla ...	July 4th, 1896 ...	...
Majunga-Tananarive ...	April 1st, 1898 ..	April 7th, 1898
Saigon-Bangkok	„ 12th, 1898 ...	„ 13th, 1898
„ „	„ 14th, 1898 ...	„ 14th, 1898
„ „	„ 14th, 1898 ...	„ 15th, 1898
„ „	„ 15th, 1898 ...	„ 16th, 1898
„ „	„ 16th, 1898 ...	„ 19th, 1898
„ „	„ 20th, 1898 ...	...

The Telephone Service.—The St. Pancras Vestry, as the road authority for the parish, has refused to give sanction to the National Telephone Company to place their mains, pipes or wires underneath the streets of St. Pancras until the interests of the public in regard to the telephone service are duly secured by statute.

CONTRACTS OPEN AND CLOSED.

OPEN.

Aberdeen—The Council invites tenders for the supply and laying of about 10 miles of ·67 single core feeder cable, 5 miles of ·2 three-core network cable, and 3¾ miles of arc lamp series cable. The cable is to be armoured and laid in wooden casing. Under another contract the Harbour Commissioners invite tenders for the supply and erection of 62 arc lamps and three leading lights, each consisting of four arc lamps. All lamps to be Brockie-Pell or Crompton-Pochin. Both the contracts will have to be completed by August 31st, and particulars in both cases can be obtained from the Corporation Electricity Works, Cotton Street. See our "Official Notices" this week.

Belgium.—May 31st. The Municipal Authorities of Ixelles, a suburb of Brussels, are inviting tenders until May 31st for the exclusive concession for the supply of electrical energy for lighting and power purposes during a period of 26 years, that is, to September 1st, 1924. Tenders to be sent to the Secretariat de la Commune d'Ixelles, Brussels, from whence particulars may be obtained.

Bootle.—April 25th. The Corporation wants tenders for the supply and erection of arc and incandescent lamps, lamp posts and accessories. Engineer, Mr. T. L. Miller, Liverpool. See our "Official Notices" April 15th.

Dudley and Stourbridge.—The Dudley, Stourbridge, and District (Staffs.) Electric Traction Company is inviting tenders for the erection and completion of a power station (with chimney stack), car shed, walling, &c., on a site near Dudley Road, Hart's Hill, Brierley Hill. Drawings, specification, &c., from Mr. Thomas Robinson, architect and surveyor, Victoria Chambers, Stourbridge, on deposit of £1 1s.

Edinburgh.—April 23rd. The Midlothian and Peebles Lunacy Board is inviting tenders for the installation of electric light in the Asylum at Rosslynlee, near Edinburgh, including (1) generating plant, accumulators, switchboard, &c.; (2) wiring, fittings, &c. Particulars may be obtained on application to Prof. Bailey, Heriot-Watt College, Chambers Street, Edinburgh.

Hyde.—May 5th. A Corporation Committee invites tenders for the supply and fixing of gas engine, dynamo, wires, fittings, &c., for electric lighting at the new technical school and free library. Engineers, Messrs. Lacey, Clirehugh & Sillar, 78, King Street, Manchester. See our "Official Notices" this week for particulars.

London.—May 17th. The Bethnal Green Board of Guardians invites tenders for the supply of plant, and installing the electric light at the new infirmary, Palestine Place. Plans, &c., to be obtained from the architects, Giles, Gough & Trollope, 28, Craven Street, Charing Cross, W.C. See our "Official Notices" this week for particulars.

Roumania.—April 30th. Tenders are being invited until the 30th inst. by the Roumanian Post and Telegraph Authorities in Bucharest, for the supply of 50 tons of galvanised iron wire, 10 tons of galvanised steel wire, and 5 tons of tinned copper wire. Particulars may be obtained from, and tenders to be sent to, La Direction Générale des Postes et Telegraphes, Bucharest, Roumania.

Sunderland.—April 29th. The Corporation is inviting tenders for the supply of a high-speed 225-kw. steam dynamo, and two Lancashire or Galloway boilers. Borough electrical engineer, Mr. J. F. C. Snell. See our "Official Notices" April 15th for particulars.

Switzerland.—April 30th. Plans and estimates are being invited, says the *Contract Recorder*, by the Government authorities of Fribourg, Switzerland, until April 30th next, for a projected electricity generating station to be established at Hauterine. Water-power is to be utilised, and the station will have a capacity of about 6,000 H.P. A premium of £120 will be awarded to the three schemes submitted which are considered to be the best. Plans and estimates are to be sent to the Department des Travaux Publics, Fribourg, Switzerland, from whence full particulars of the competition may be obtained.

The War Office.—April 27th. The Secretary of State for War is prepared to receive offers, competitive designs and specifications for the supply of portable electric search light apparatus. Particulars from the Director of Army Contracts, War Office, Pall Mall, S.W. See our "Official Notices" February 4th.

Victoria.—June 24th. The Council of the city of Hawthorne (Colony of Victoria, Australia) is inviting tenders for the supply and erection of buildings, boilers, engines, dynamos, transformers, mains, meters, arc lamps, poles; also running the plant for three years. See our "Official Notices" March 11th.

Waterloo (Lancs.).—April 26th. Tenders are invited for wiring and fitting the Town Hall for electric lighting. Particulars from Mr. F. S. Yates, surveyor to the District Council.

CLOSED.

Bootle.—The Town Council has accepted the tender of the Chloride Electrical Storage Syndicate for supplying and fixing two storage batteries at the electricity supply works for the sum of £1,079, and for the maintenance of same at £64 per annum.

Dudley and Stourbridge.—An inclusive contract for the electrical equipment of the Dudley and Stourbridge tramways has been placed with the British Thomson-Houston Company, Limited, and work will be commenced immediately.

Portsmouth.—A contract has been given to Messrs. Yates & Thom for the supply of boilers, feed pumps, mechanical stokers, coal conveyor, &c., at a cost of £7,900.

Walsall.—The Council has accepted the tender of Callender's Cable and Construction Company, Limited, for supplying and laying new feeders and relaying old ones for £1,815 odd.

FORTHCOMING EVENTS.

1898.

Friday, April 22nd, 5 p.m.—Physical Society. "On a Method of viewing Newton's Rings," by the Rev. T. C. Porter.

Monday, April 25th, at 8 p.m.—Society of Arts. Second Cantor lecture on "Sources of Commercial India-rubber," by Dr. D. Morris, C.M.G.

Tuesday, April 26th, at 8 p.m.—The Institution of Civil Engineers. Annual general meeting to receive report and to elect council and auditors.

Wednesday, April 27th, at 7.30 p.m.—Institution of Electrical Engineers. Students' meeting. Paper on "The Commercial Development of the Electric Lighting of Small Towns," by C. Milton and H. Bell.

NOTES.

Prevention of Vibration.—*Apropos* of the recently much-advocated felt mat for deadening noise on solidly laid tramways, *Cassier's Magazine* names a case where a noisy engine was completely checked of jar and tremble by bedding it in a shallow pan of hair felt placed between the stone bed and the engine frame, the pan sides preventing the lateral extension of the felt. Noise due to rigid connections may be deadened considerably in this way, vibration or sound waves being probably unable to propagate themselves between diverse materials. Resonance is the best term to employ in respect of many cases where noisy machinery is found. The same applies to the resonance of a rigid rail or tramway which it is hoped to check by the felt mat, which is made from one-third of an inch in thickness and upwards. Such deadness of sound ought, however, not to be thick, or they will yield under passing pressure, and place vehicles in the position of always running uphill, which it is the object of the rigid girder rail to prevent. Mr. Deacon, of Liverpool, professes that an elastic supported rail is productive of great saving, but he does not advance figures to show the difference in traction where a rail is rigidly supported, or has a yielding elastic support.

Some New Galvanic Cells.—Carbon electrodes immersed respectively in concentrated chlorine water and sodium thiosulphate solution, form essential features of a new cell described by H. Pauling in the *Zeitschrift fur Elektrochemie*, No. 5, page 332. The liquids are separated by a porous pot soaked in brine. During action the sulphur separates out from the thiosulphate solution. Pauling has tested this cell, and found that the electromotive force fell on short circuit, from 0·64 volt to 0·47 volt, and then remained constant for five hours, the current passing being 0·7 ampere. In another cell, which is also described by H. Pauling, the electrolyte is a concentrated solution of ferric chloride, and the electrodes are of iron and carbon respectively. The author considers that the following reactions take place in this cell:—

$$(1)\ 3\ Fe\ Cl_3 = 3\ Fe\ Cl_2 + 3\ Cl.$$
$$(2)\ Fe + Cl = Fe\ Cl_3.$$

The chlorine gas reconverts the ferrous chloride into ferric chloride. The principal advantages of this cell are its cheapness and freedom from odour, whilst the electromotive force is only 0·9 volt. Depolarisation is, of course, the chief difficulty, but by means of a simple mode of construction a constant flow of ferric chloride solution is maintained throughout the cell, and this is claimed to be sufficient to ensure complete depolarisation. In the same number of the *Zeitschrift*, page 383, there is a paper by F. W. Kuster on the last-mentioned cell. Kuster considers that the process which takes place in the cell is better represented by the equation

$$2\ Fe''' + Fe = 3\ Fe'',$$

the dashes indicating the number of positive charges of electricity. Since the iron is always contaminated with finely-divided carbon or iron carbide, local galvanic action must occur of the same kind as the main reaction taking place in the cell. That this is the case was proved by an experiment in which the iron plate lost 1·66 grammes in weight, whereas the loss corresponding to the quantity of electricity produced should have been 0·31 gramme. That the iron dissolves as ferrous chloride and not as ferric salt was shown by immersing the iron plate in a solution of sodium chloride and the carbon plate in a solution of ferric chloride. After allowing the current to pass for some time, the solution in the vicinity of the iron plate was found to contain ferrous salt alone without a trace of ferric iron.

Lectures, &c.—A demonstration of the application of electricity to cooking and heating purposes was given on Monday last week before the Edinburgh South Side Merchants' Association by Mr. Hugh Fleming.

On 11th inst., before the Royal Scottish Society of Arts at Edinburgh, Mr. William Shaw, Pleasance, read a paper, in which he gave a detailed description of an electric system of mechanical ventilation which he had invented.

Tramways and the Light Railways Act, 1896.—In reply to an application addressed to the Board of Trade, we have received the following important communication:—"With reference to your letter of 13th inst. on the subject of the above-named Act, I am directed by the Board of Trade to state that they have been advised by their solicitor that there is no reason why an application under the Light Railways Act, 1896, for a light railway entirely within the limits of a borough should not be entertained, provided the order is properly framed."

Appointment Open.—The Government of Lagos, West Africa, want an engineer of Government vessels (£350 per annum). Applicants must be marine engineers with a knowledge of electric lighting plant. Preference will be given to marine engineers who are now in electricity works. See our "Official Notices" this week for conditions of engagement, &c.

The Electrical Work at Newington Baths.—Messrs. Sharp & Piper, in equipping the recently opened Newington Baths with electrical plant, have completed a most interesting installation. The plant consists of a Thwaites-Crichton double 6 inches and 10 inches × 6 inches compound engine developing at 80 lbs. pressure 35 B.H.P. at 470 revolutions. This is coupled to an Easton, Anderson and Goolden dynamo (Fynn's patent), of four-pole shunt-wound type. This machine has an output of 80 amperes at 225 volts, and is fitted with shunt regulating resistance. There are 125 11-plate R type Chloride Electrical Storage Company's cells having a total capacity of 276 ampere-hours, when discharging in six hours. The battery is used mostly for the light loads. The lighting is done by arc and incandescent lamps, there being 16 32-hours 10 amperes Brockie-Pell lamps placed as follows:—Four in series in first class swimming bath, four in series in second class swimming bath, two on pavement on ornamental standards in series with two in ladies' swimming bath, and two in manure yard in series with two on brackets on outside of building. Street standards, fitted with two 32-C.P. each, to turn on after 12 at night. The incandescent lighting is done by 320 incandescent Ediswan lamps, 16 and 8 C.P., having a terminal voltage of 220. The wires and mains through basement and wash-houses, &c., are enclosed in iron armoured insulated conduits, fitted with drawing-in boxes, &c., and we must say, from our observation, that the character of the work done at the Newington Baths is certainly an argument in favour of interior conduits. The wires and mains in the dwelling portions are enclosed in casing thoroughly varnished inside and out with shellac varnish. As we have already indicated, the fittings throughout are specially designed for 220-volt work. The electrical work in the stables is interesting, because it comprises both lighting and electrical driving. There are 32 16-C.P. 220-volt lamps, arranged on special fittings, and the whole of the provender machinery is driven by electric motors. The whole of this part of the contract, including the shafting, motor, chaff cutter, corn mills, friction hoist and elevators, was supplied and fixed by Sharp & Piper, and designed by Mr. J. B. Cumberland, chief of the engineering staff of the above firm. It comprises a 12½-13 H.P. Sharp and Piper motor, 50 amperes, 220 volts, 780 revolutions, shunt-wound, and fitted with patent starting resistance, driving a 2¼ diameter shafting, which runs at 200 revolutions. To this is geared the chaff cutter, fitted with fast and loose pulleys and bell-striking gear, capable of cutting and sifting 25 cwt. of chaff per hour, the power required being seven to eight B.H.P. Then there is the oat mill, fitted with fast and loose pulleys, capable of crushing 25 bushels oats per hour, the power required in this case being four B.H.P. In addition is a bean mill, fitted with fast and loose pulleys, and capable of splitting 25 bushels of beans, peas, or maize per hour, the power required being 1½ B.H.P. There is friction hoist for raising light loads, which can be made to raise, lower, or break by means of one pull on cord running off the shaft. It is perhaps hardly necessary to say that the character of the installation is very complete, and reflects much credit upon the contractors.

Internal Resistance of Galvanic Cells.—Last year, Ernst Haagn, in the *Zeitschrift für Physikalische Chemie*, No. 23, pages 97—122, described a method for the determination of the internal resistance of cells, which is fundamentally similar to the Wheatstone bridge method for the comparison of the capacities of condensers, the known ratio of the capacities giving the ratio of the resistances. The availability of the method for various classes of cells is first proved by comparison of the results obtained with those obtained by other methods. The experiments afterwards show that the internal resistance of cells during electrolysis is quite independent of the current strength or current density. The slight variations which were found to occur are traceable to alterations in the concentration of the solutions. In the case of accumulators during discharge, the resistance at first slowly increases, the rate of increase being more rapid towards the end, whilst during the charging of the cell the reverse changes occur, the resistance at first diminishing rapidly, and afterwards more slowly. The cause of this variation is partly the change in concentration of the sulphuric acid, and partly alteration of the surface of the lead plates. Haagn has continued his researches, and has more recently turned his attention to the determination of the resistance of galvanic cells with small polarisation capacity. If the resistances in the arms of a Wheatstone bridge are R_1, R_2, R_3, and R_4 (R_3 and R_4 referring to the halves of the bridge wire), and the arms 1 and 2 contain in addition capacities, C_1 and C_2, balance is obtained when $R_1 / R_2 = R_3 / R_4$, and $R_3 / R_4 = C_2 / C_1$ simultaneously. The present method is based on this. The cell, of which the resistance (R_1 say) is to be measured, has a capacity, C_1. The measurements are made by the telephone method, and in order to get a good minimum, the arm of the bridge containing the comparison resistance, R_2, must also contain a condenser of capacity, C_2, fulfilling the requirements of the above equation. A suitable condenser may be made by immersing two aluminium plates in sulphuric acid of maximum conductivity; a current is then passed between them with an E.M.F. of about 10 volts for a minute, when the aluminium plates become polarised, so that a smaller E.M.F. than 10 volts causes no current to pass in the same direction, and this condition is retained for a considerable period. The capacity of the condenser is varied by varying the depth to which the plates are immersed in the acid. In order to prevent direct current from the cell passing through the telephone circuit, an air condenser is included in it. The measurement is made by first adjusting the bridge contact to an approximate minimum of sound in the telephone; a nearer approximation is obtained by adjusting the depth of immersion of the aluminium plates, and then the final adjustment of the bridge contact is made. The method is applicable, whether current is flowing through the cell or not.

Manchester Electric Lighting.—The Manchester Electricity Committee's estimates for the year ending March 31st, 1899, set down the estimated expenditure on revenue account at £53,829; estimated income, £66,000; balance, £12,171; out of which it is expected that £12,000 will be devoted to the relief of the rates. The capital expenditure is put down at £143,900. Last year the surplus was £14,080.

Personal.—As we go to press we hear that Mr. George White, managing director of the Bristol Tramways and Carriage Company, was yesterday (Thursday) elected president of the Bristol Stock Exchange.

Earl Russell Studying for the Bar.—It is stated in the daily papers that Earl Russell has entered his name for the Bar.

NEW COMPANIES REGISTERED.

Mansfield Motor Car Company, Limited (56,901).—Registered April 9th, with capital £5,000 in £10 shares, to carry on the business of automotor and cycle manufacturers, pneumatic tyre manufacturers, electrical, gas, and mechanical engineers, cycle manufacturers, ship and boat builders, machinists, fitters, &c. The subscribers (with 10 shares each) are:—W. J. Chadburn, Grove House, Mansfield, brewer; G. A. Fish, Nottingham Road, Mansfield, ironfounder; F. Hameyer, Nottingham Road, Mansfield, ironmonger; C. Manners, Edenbank, Mansfield, printer; F. A. Robinson, The Park, Mansfield, ironfounder; R. F. Vallance, The Ridge, Mansfield, architect; J. J. Ward, The Park, Mansfield, manufacturer. The number of directors is not to be less than three nor more than seven; the first are W. J. Chadburn, G. A. Fish, F. Hameyer, F. A. Robinson, R. F. Vallance, and J. J. Ward; qualification, £100; remuneration as fixed by the company. Registered by Jordan & Sons, Limited, 120, Chancery Lane, W.C. Registered office, Leeming Street, Mansfield.

Mexico Electric Tramways, Limited (56,932).—Registered April 13th, with capital £500,000 in £1 shares, to adopt an agreement with Wernher, Beit & Co., and to construct or purchase, equip, maintain and work any tramways, railways, telephone or telegraph lines, electric lighting and other works, &c. The subscribers (with one share each) are:—W. Martin, Avondale Road, Manor Road, Richmond, gentleman; R. W. Brown, 79, High Street, Beckenham, journalist; A. J. Swan, 124, Peckham Rye, S.E., gentleman; E. T. Rouse, 1, Avenue Gardens, Mill Hill Park, W., accountant; G. F. Barnett, 12, Weston Park, Crouch End, N., clerk; C. Field, 27, St. Margaret's Road, Brockley, S.E., clerk; A. W. Rogers, 8, Denning Road, Hampstead, N.W., clerk. The number of directors is not to be less than three nor more than nine; the subscribers are to appoint the first. Qualification, £500; remuneration, £500 per annum divisible. Registered by Ashurst & Co., 17, Throgmorton Avenue, E.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Eastern Telegraph Company, Limited (6,338).—This company's return, made up to February 3rd, was filed on March 9th. The capital is £4,700,000 in £10 shares, of which 469,989 have been taken up. The full amount has been called and paid.

Pontypool Electric Light and Power Company, Limited (36,109).—This company's return was filed on March 25th, when 1,143 shares were taken up out of a capital of £10,000 in £5 shares. £5 per share has been called on 669, and £4 per share on 474, and £5,241 has been paid.

Birmingham Electric Supply Company, Limited (30,296).—This company's annual return was filed on March 28th, when the capital of £200,000 in £5 shares was fully taken up. £5 per share has been called, and £199,926 10s. has been paid, leaving £73 10s. in arrears.

Peru Telephone Company, Limited (56,290).—This company's return, made up to January 14th, was filed on March 8th. 7 shares have been taken up out of a capital of £100,000 in £5 shares, but no calls have been made.

Westminster Electric Supply Corporation, Limited (27,061).—This company's annual return was filed on March 10th, when the whole capital of £399,500 in £5 shares was taken up and paid for in full.

Cuba Submarine Telegraph Company, Limited (4,710).—This company's return was filed on March 9th, when the whole capital of £220,000 in £10 shares was taken up and paid for in full.

Anglo-American Telegraph Company, Limited (2,891).—This company's return was filed on March 23rd, when the whole capital of £7,000,000 stock was fully paid up.

Charing Cross and Strand Electricity Supply Corporation, Limited (29,122).—This company's return was filed on March 24th, when 49,999 shares were taken up out of a capital of £250,000 in £5 shares. £5 per share has been called, and £249,996 paid. £1 has been paid on a forfeited share.

St. James's and Pall Mall Electric Light Company, Limited (26,015).—This company's return was filed on March 15th. The capital is £300,000 in 100 founders' shares of £1 each, and 39,980 ordinary and 20,000 preference shares of £5 each. 100 founders', 31,980 ordinary and 20,000 preference have been taken up, the full amount called, and £260,000 paid.

National Telephone Company, Limited (15,066).—This company's return was filed on April 6th. The capital is £4,000,000 in 150,000 first preference shares of £10, 150,000 second preference shares of £10, 250,000 third preference shares of £5, and 490,000 ordinary shares of £5 each. All these shares, except 5,403 ordinary have been taken up, and 28,284 third preference and 44,413 ordinary are considered as paid. The full amount has been called on the others, and £3,609,500 has been paid.

Scarborough Electric Supply Company, Limited (37,569).—This company's return was filed on March 10th. 4,000 shares have been taken up out of a capital of £50,000 in £10 shares, and £9 per share has been called. £35,967 has been paid, and £33 is in arrears.

G. R. Blot & Co., Limited (54,459).—This company's statutory return was filed on February 24th. 30,693 shares have been taken up out of a capital of £75,000 in £1 shares, of which 14,400 are considered as paid. The full amount has been called, and £16,293 received on the rest.

CITY NOTES.

The Oriental Telephone and Electric Company, Limited.

The report of the directors for the year ended December 31st, 1897, to be presented at the fourth ordinary general meeting of the company, to be held at the Cannon Street Hotel, London, on Wednesday, April 27th, 1898, at one o'clock p.m., states that the revenue account shows a balance to credit of £10,909 18s., transferred to profit and loss, and including £629 14s. 3d. brought forward from 1896, and after deduction of £2,858 8s., representing the interim dividend of 4d. per share paid on October 30th last, there remains £8,681 4s. 3d. to be dealt with. The directors recommend the appropriation of this sum as follows:—£5,716 16s. in payment of a final dividend of 8d. per share, free of income-tax, making 5 per cent. for the year; £1,000 to extinguish the balance at debit of Colombo Exchange "suspense account"; £1,000 to reserve fund; and to carry forward £964 8s. 3d. The revenues of the Indian companies continue satisfactory. The Bombay Company has paid a dividend of 6 per cent., as against 5 per cent. for 1896, and has reserved from profits of the year a further sum of Rs. 30,000, which has been deemed desirable, in consequence of the continuance of the plague in that city and the unsatisfactory outlook in connection therewith. The Telephone Company of Egypt has declared, as hitherto, a dividend of 6 per cent. on its preferred shares, and the business still continues to develop. The China and Japan Telephone Company has paid its debenture interest, and makes fair progress both at Shanghai and Hong Kong. The electric lighting branch of the Company's business, carried on at several of its stations, has paid its way for the past year, and the current year opened with a fair amount of business in hand. In accordance with the articles of association, Mr. Lloyd and Mr. Frost retire at this meeting. Mr. Lloyd offers himself for re-election; Mr. Frost does not do so. The auditors, Messrs. Deloitte, Dever, Griffiths & Co., also retire, and offer themselves for re-election.

The Great Northern Telegraph Company of Copenhagen.

The working accounts for the year 1897 states that the net receipts during 1897, including the balance brought forward from 1896, amount to £332,474 11s. 2d., exclusive of interest on the investment of the reserve and renewal fund, which has been credited direct to this fund. Deducting £39,361 2s. 3d. for interest and authorisation of debentures, and £75,000 for interim dividends (already paid), there remains a balance of £218,113 8s. 11d., which the board proposes to distribute as follows:—Extra dividend (making the total dividend for the year 10 per cent.), £75,000; reserve and renewal fund, £77,777 15s. 6d.; pension fund of the staff, £2,777 15s. 7d.; directors' remuneration, £1,500; balance to be carried forward, £61,057 17s. 10d.

Indo-European Telegraph Company.

The ordinary general meeting of this company was held on Wednesday at Winchester House, Mr. J. Herbert Tritton presiding.

The Chairman, in moving the adoption of the report, expressed regret at the death of Mr. Earle. He said Mr. T. W. Andrews had been elected to the board in Captain Earle's place. The business compared very favourably with that of last year. The revenue had increased by £7,000. They had made last year certain concessions, and as a result they had not sustained any loss. It was probable there would be an increase in expenditure during the coming year—for instance, they were going to put down another wire between Warsaw and Odessa, permission having been granted by the Russian Government. They were also making some alterations in Persia. They had adopted the automatic Wheatstone apparatus with satisfactory results. The line had been working for 30 years, and there had been great improvements, but more were possible, especially in the wild country of the Caucasus. Mr. T. W. Andrews had been all over the line, and was satisfied with its condition. Replying to a question as to what would happen in the event of a war between England and Russia, the chairman said that he could not say what might happen to them, but it was agreed that their line was neutralised.

The report was adopted.

Calcutta Tramways Company, Limited.

At the ordinary general meeting held on Tuesday at the offices, 11, Abchurch Lane, Mr. E. C. Morgan, in moving the adoption of the report, said that the negotiations proceeding with the Calcutta Corporation last year for the use of mechanical traction had not, he was sorry to say, been brought to a satisfactory conclusion. In December last a proposal was received from the Corporation, but it was of such a nature as to render its acceptance impossible. A reply had been forwarded by the directors in which they stated that if the Corporation were prepared to agree that electric traction by the overhead trolley system should be applied to the Calcutta tramways, and any extension of the present system, and to give every necessary and reasonable facility for its introduction and use, the board would be prepared to recommend the shareholders to sanction an agreement by the company with the Corporation to the following effect:—(1) That the perpetual rights of the company to the tramways under the existing concession, unless purchased by the Corporation at 140 per cent. on the capital invested, be surrendered, and that, in lieu thereof, (2) the Corporation should have the right, on giving six months' previous notice in writing to purchase the tramways at the end of 42 years from January 1st, 1901, or at the end of any 10 years thereafter, on paying the company in cash 25 years' purchase of the average profits of the undertaking during the last three years of the term; (3) that the company would take at its own charge the necessary steps for applying electric traction to the tramways without asking the Corporation for any other concession or alteration of the existing concession, and would provide all the means necessary for that purpose, and pay Rs.30,000 annually by way of track rent throughout the term of the concession. This reply of the directors had been referred by the Corporation to a committee, which, so far as the board knew, had not yet met. If the Corporation continued to let the matter drag on, the directors proposed to represent to the Lieutenant-Governor of Bengal the actual state of affairs, and ask him to bring some pressure to bear on the municipal authorities, because it was impossible for the board to keep their offer open indefinitely. In the meantime their traffic had so far improved that they would be able to go on working the line satisfactorily with horses.

Submarine Cables Trust.

The report of the trustees for the year to 15th inst., to be submitted to the annual meeting of the certificate holders to be held in London on 27th inst., states that the revenue for that period, including the balance of £159 brought from the previous accounts, amounted to £23,156 During the past year the following coupons have been met:—Due April 15th, 1897, paid 10s. balance July 15th, 1897; due October 15th, 1897, paid £3 in full on due date; due April 15th, 1898, paid £3 in full on due date. The expenses of the trust amounted to £1,150, and the payments on account of the coupons to £21,976, together £23,136, leaving a balance of £20 to be carried forward. The trustees, in accordance with reasons given in last year's report, have sold the balance of their holding (£69,200) in Anglo-American Telegraph Company, Limited, deferred stock, and by a unanimous resolution of the trustees passed at a meeting called with express notice of the object, at which all the trustees were present in person, decided to invest the proceeds of such sale in the purchase of other securities of the character mentioned in the deed of trust. The certificate holders will be asked, in accordance with the provisions of the deed of trust, to confirm the resolution of the trustees and sanction such investments.

Apostoloff Automatic Telephone Parent Syndicate.—Mr. J. W. Cohen, of 13 and 14, Abchurch Lane, E.C., the liquidator of this syndicate, has declared a first dividend at the rate of 10s. in the £ upon the amounts of the respective debts of the creditors of the company whose debts have been admitted and proved. The liquidator states that there will be more than sufficient to pay creditors 20s. in the £, which payment he hopes to complete shortly.

Rand Central Electric Works, Limited.—This company announces that warrants for the dividend at the rate of 6 per cent. per annum for the period ended December 31st last have been posted to the shareholders registered in the books of the company as on March 31st.

Stock Exchange Notices.—The Committee has been requested to allow Chelsea Electricity Supply Company, Limited—Further issue of 8,000 ordinary shares, Nos. 32,501 to 40,500, to be quoted in the Official List.

TRAFFIC RECEIPTS.

The Bristol Tramways and Carriage Company, Limited.—The receipts for the week ending April 15th, 1898, were £3,278 4s. 4d.; corresponding period, 1897, £2,219 7s. 7d.; increase, £1,053 16s. 9d.

The City and South London Railway Company.—The receipts for the week ending April 17th, 1898, were £945; week ending April 18th, 1897, £845; increase, £100; total receipts for half-year, 1898, £16,771; corresponding period, 1897, £16,684; increase, £87.

The Cuba Submarine Telegraph Company.—The receipts for the month of December were £4,595, as compared with £3,818 in the corresponding month of last year.

The Dover Corporation Electric Tramways.—The receipts for the week ending April 16th, 1898, £180 7s.; total receipts to April 16th, 1898, £1,695 4s. 2d.

The Dublin United Tramways Company.—The receipts for week ending Friday, April 15th, 1898, were £3,338 9s. 2d.; corresponding week last year, £2,640 9s. 9d.; increase, £697 19s. 5d.; passengers carried, 588,131; corresponding week last year, 456,784; aggregate to date, £40,629 4s. 7d.; aggregate to date last year, £37,726 4s. 7d.; increase to date, £2,903; mileage open, 34 miles.

The Liverpool Overhead Railway Company.—The receipts for the week ending April 17th, 1898, amounted to £1,736; corresponding week last year, £1,478; increase, £258. 1898, includes Easter Monday. 1897, includes Good Friday and Easter Sunday.

The Western and Brazilian Telegraph Company, Limited.—The receipts for the week ending April 15th, 1898, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company Limited, were £2,690.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue.	NAME.	Stock or Share. ‡	Dividends for the last three years.			Closing Quotation, April 13th.	Closing Quotation, April 20th	Business done during week ended April 20th, 1898.	
			1895.	1896.	1897.			Highest.	Lowest
137,400£	African Direct Teleg., Ltd., 4 % Deb.	100	4 %	...	...	100 104	100 —104	...	...
25,800	Amazon Telegraph, Limited, shares...	10	...	...	...	7 — 8	7 — 8	...	...
125,000	Do. do. 5% Debs. Red.	100	...	...	...	93 — 96	93 — 96	...	...
923,960£	Anglo-American Teleg., Ltd.	Stock	£2 9s.	£2 13s.	3 %	61 — 64	59 — 62xd	61	...
3,038,020£	Do. do. 6 % Pref.	Stock	£4 18s.	£5 6s.	6 %	111½ 112½	109½ 110½xd	111	109½
3,038,020£	Do. do. Defd.	Stock	...	...	...	12¾— 13¼	12 — 12½	12⅝	12⅜
130,000	Brazilian Submarine Teleg., Ltd.	10	7 %	7 %	7 %	16½ — 17	16 — 16½	16½	...
75,000£	Do. do. 5 %, Debs., 2nd series, 1926	100	5 %	...	...	112 —116	112 —116	...	...
44,000	Chili Telep., Ltd., Nos. 1 to 44,000	5	4 %	4 %	...	3 — 3½	3 — 3½	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	8 %	...	185 —190	175 —185	...	...
918,297£	Do. Do. Sterling 500 year 4% Deb. Stock Red.	Stock	...	...	...	104 —106	104 —106	105½	105
224,850	Consolidated Telep. Const. and Main., Ltd.	10/-	1½%	2 %	...	¾— ⅞	¾— ⅞	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	7 %	6½— 7½	6½— 7½	...	...
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	14½ - 15½	14½ - 15½	15½	...
12,931	Direct Spanish Teleg., Ltd.	5	4 %	4 %	4 %	4 — 5	4 — 5	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	10 %	10 — 11	10 — 11	...	...
30,000£	Do. do. 4½ % Debs. Nos. 1 to 6,000 ...	50	4½%	4½%	4½ %	103 —106%	103 —106%	...	...
60,710	Direct United States Cable, Ltd.	20	2¼%	2¼%	...	10⅜— 11¼	10¼ 10⅜xd	11 1/16	10⅜
120,000	Direct West India Cable 4½% Reg. Deb	100	...	...	...	99 —104	99 —102	...	...
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6¼%	6½%	...	17⅜ 18¼	17¼ 17⅜xd	17⅞	17½
70,000	Do. 6 % Cum. Pref.	10	6	6%	...	18½ 19½	18 - 19 xd	18½	18
89,900£	Do. 5 % Debs., repay. August, 1899	100	5 %	5%	...	100 103	100 —103	...	..
1,302,615£	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4%	...	128 —131	127 - 130	...	...
250,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7½	...	18⅜— 19½	18½ — 18⅝	19	18⅜
25,200£	Do. 5 % (Aus. Gov. Sub.), Deb., 1908, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,226	100	5 %	5%	...	99 —103	99 - 103	...	...
100,500£	Do. do. Bearer, 1,050—3,975 and 4,227—5,400	100	5 %	5%	...	100 —103	100 —103	...	...
320,000£	Do. 4 % Deb. Stock	Stock	4 %	4%	...	128 —131	127 - 130	...	...
35,100£	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	5%	...	99 - 103	99 —103	...	...
46,500£	Do. do. do. to bearer, 2,344 to 5,586	100	5 %	5%	...	100 —103	100 —103	...	...
300,000£	Do. 4 % Mort. Debs. Nos. 1 to 3,000, red. 1929	100	4 %	4%	...	102 —105	102 —105	102	...
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4%	...	107 —110 %	107 —110%	...	...
180,227	Globe Telegraph and Trust, Ltd.	10	4½%	4½%	...	11⅜ - 12½	11½ - 12	11⅜	...
180,042	Do. do. 6 % Pref.	10	6 %	6%	...	17½ - 18	17½ - 17⅝	17⅝	17½
150,000	Great Northern Teleg. Company of Copenhagen	10	10 %	10%	10 %	29½ - 30½	29½ - 30½	...	...
160,000£	Do. do. do. 5 % Debs.	100	5 %	5%	5 %	100 —103	100 - 103	...	...
97,000	Halifax and Bermuda Cable Co., Ltd., 4½ % 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	...	...	...	95 —100	95 —100	...	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10%	...	52 — 55	52 — 55	...	...
100,000£	London Platino-Brazilian Teleg., Ltd. 6 % Debs.	100	6 %	6%	...	106 —109	106 —109	...	...
28,000	Montevideo Telephone 6% Pref., Nos. 1 to 28,000... ...	5	4 %	4 %	4 %	2 — 2½	2 — 2½	...	...
484,597	National Teleph., Ltd., 1 to 484,597	5	5⅛%	5⅛%	6 %	5½ 6	5½— 6	5 1/16	5½
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	16 — 18	16 — 18	...	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	15 — 17	15 — 17	...	...
250,000	Do. 5 % Non-cum. 3rd Pref., 1 to 250,000	5	5 %	5 %	5 %	5½ 6	5½ — 6	5½	...
1,329,471£	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½ %	100 —105	100 —105	102½	...
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	5 %	5 %	5 %	⅜— ⅝	⅜ ⅝	9/16	...
100,000£	Pacific and European Tel., Ltd., 4 % Guar Debs, 1 to 1,000	10	4 %	4 %	...	105 108	105 —108	...	...
11,839	Reuter's Ltd.	8	5 %	5 %	...	8 — 9	8 — 9	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	140 - 145	136 - 141xd	139	..
58,000	United River Plate Teleph., Ltd.	5	4 %	5 %	...	4 — 4½	4 — 4½	...	...
146,733£	Do. do. 5 % Debs.	Stock	5 %	...	...	105 —108	105 —108	...	...
15,609	West African Teleg., Ltd., 7,561 to 23,169	10	4 %	*nil*	...	3½ - 4½	3½ - 4½	...	...
213,400£	Do. do. do. 5 % Debs.	100	5 %	5 %	...	99 —102	99 —102	...	...
54,269	Western and Brazilian Teleg., Ltd.	15	3 %	2 %	...	12 — 12½	11⅝— 12½	12 3/16	12
33,129	Do. do. do. 5 % Pref. Ord. ...	7½	5 %	5 %	...	7⅝— 8½	7½ — 8	7⅝	...
33,129	Do. do. do. Def. Ord ...	7½	1 %	*nil*	...	4½— 5	4½— 4⅝	...	...
389,521	Do. do. do. 4 % Deb. Stock Red. ...	Stock	...	...	...	106 —109	106 —109	...	...
88,321	West India and Panama Teleg., Ltd.	10	⅝%	1 %	...	½ - ⅝	½— ⅝	...	...
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	...	7½ — 8	7½ — 7⅝	7 7/16	...
4,689	Do. do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	...	5 — 7	5 — 7	...	...
80,000£	Do. do. 5 % Debs. No. 1 to 1,600 ...	100	5 %	5 %	...	105 —108	105 —108	...	...
1,163,000$	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ...	$1000	7 %	7%	...	105 —110	105 —110	...	...
160,100£	Do do. 5 % Ster. Bonds. ...	100	5 %	5%	...	100 —105	100 —105	...	...

ELECTRICITY SUPPLY COMPANIES.

30,000	Charing Cross and Strand Electy. Supply	5	5 %	6 %	7 %	13½ — 14½	13½ — 14½	...	...
20,000	Do. do. do. do. 4½ % Cum. Pref.	5	...	...	...	6 — 6½	6 — 6½	...	...
26,000	*Chelsea Electricity Supply, Ltd., Ord., Nos. 1 to 19,277 ...	5	5 %	5 %	6 %	10½ - 10⅝	10 — 11	10 7/16	...
60,000	Do. do. do. 4½ % Deb. Stock Red. ...	Stock	4½%	4½%	4½%	115 —117	115 —117	...	...
50,000	City of London Elec. Lightg. Co., Ltd., Ord. 40,001—90,000	10	5 %	7 %	10 %	26 — 27	26 — 27	26⅛	26¼
10,000	Do. do. Prov. Certs. Nos. 90,001 to 100,000 £5.	10	...	...	...	19 — 20	19 — 20	...	...
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	17½— 18½	17½ - 18½	18	...
400,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	5 %	129 —134	129 —134	...	...
30,000	County of Lond. & Brush Prov. E. Ltg. Ltd., Ord. 1—30,000	10	*nil*	*nil*	*nil*	14⅜— 15¼	14½ — 15	14⅜	...
20,000	Do. do. do. 6% Pref., 40,001—60,000 ...	10	6 %	6 %	6 %	15½— 16	15½— 16	16	15½
17,400	Edmundsons Elec. Corp., Ltd., ord. shares 1—17,400 ...	3	...	...	...	3½— 3⅝	3½— 3⅝	...	...
10,000	House-to-House Elec. Light Supply, Ord., 101 to 10,100	5			4 %	10½ - 11½	10 — 11	10⅞	10⅜
10,000	Do. do. 7 % Cum. Pref. ...	5	7 %	7 %	7 %	11½ — 12	11 — 12	...	...
62,400	*Metropolitan Electric Supply, Ltd., 101 to 62,500 ...	10	4 %	5 %	6 %	19½ - 20½	18 — 19	19⅜	18⅜
220,000£	Do. 4½% first mortgage debenture stock	...	4½%	4½%	4½ %	117 —121	117 — 121	117	...
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	2 %	4 %	6 %	20 — 21	19½— 20½	20⅜	20
31,980	*St. James's & Pall Mall Elec. Light Co., Ltd., Ord.	5	7½%	10½%	14½ %	17½— 18½	17½— 18½	18⅜	...
20,000	Do. do. 7 % Pref., 20,001 to 40,000	5	7 %	7 %	7 %	10 — 11	10 — 11	...	..
50,000	Do. do. 4 % Deb. stock Red. ...	Stock	...	...	4 %	107 —110	107 —110	...	..
43,341	South London Electricity Supply, Ord., £2 paid	5	...	...	...	2½— 2⅝	2½— 2⅝	2⅝	2 3/16
79,900	Westminster Electric Supply Corp., Ord., 104 to 80,000 ...	5	7 %	9 %	12 %	16½ — 17½	16½— 17½	17⅛	16½

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid. § Dividends paid in deferred share warrants, profits being used as capital.

Dividends marked ‖ are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1895.	1896.	1897.	Closing Quotation April 18th.	Closing Quotation April 20th.	Business done during week ended April 20th, 1898 Highest	Lowest
30,000	British Electric Traction	10		...	...	16 — 16½	15½ — 16½	16¼	...
90,000	Brush Elecl. Engng. Co., Ord., 1 to 90,000...	£	2½%	*nil*	*nil*	1⅝ 2	1⅝ 1⅞	1⅝	1⅝
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	£	3 %	*nil*	4 %	2¼— 2½	2¼ — 2½	2¼	...
125,000£	Do. do. 4½ % Perp. Deb. Stock.... ...	Stock	...	...	...	113 114	110 114	...	...
50,000	Do. do. 4½% 2nd Deb. Stock Red. ...	Stock	...	...	...	102 —105	102 —105	103½	102½
19,894	Central London Railway, Ord. Shares	10	...	...	...	10¼— 10⅝	10¼ — 10⅝	10⅝	10½
129,179	Do. do. do. £6 paid	10	...	...	...	6¼— 6⅝	6¼ — 6⅝	6⅝	...
59,254	Do. do. Pref. half-shares £1 pd. ...	...	...	...	...	1½— 2	1½— 2	...	...
67,680	Do. do. Def. do. £5 pd. ...	...	...	...	...	4⅜ — 4⅝	4⅜— 4⅝	...	...
630,000£	City and South London Railway	Stock	1 1/16%	1 2/16%	1 7/8%	68 — 70	68 — 70	69⅞	68½
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	5	*nil*	...	...	2 — 2½	2 — 2½	...	...
99,261	Edison & Swan United Elec. Lgt., Ltd., "A" shrs, £3 pd. 1 to 99,261	5	5 %	5½%	...	2¼ - 2⅝	2¼ 2⅝	...	...
17,139	Do. do. do. "A" Shares 01—017,139	5	5 %	5½%	...	4 — 5	4 — 5	...	...
194,023	Do. do. do. 4% Deb. stock Red. ...	100	..	...	...	103 —105	103 —105	...	...
110,000	Electric Construction, Ltd., 1 to 110,000	2	5 %	6 %	...	2⅝ - 2⅞	2⅝ - 2⅞	2 1/16	2⅛
16,343	Do. do. 7 % Cum. Pref., 1 to 16,343 ..	2	7 %	7 %	...	3⅛ 3⅜	3⅛ - 3⅜	3 3/16	...
111,100	Do. do. 4% Perpetual 1st Mort. Deb. Stock	Stock	...	...	...	106 —108	106 —108	...	...
91,196	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	.	...	...	⅛ - ¼	⅛ - ¼	...	...
67,275	Elmore's Wire Mfg., Ltd., 1 to 69,385, issued at 1 pm. ...	2	.	...	...	⅜ - ⅝	⅜ - ⅝	...	...
9,600£	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	10¼%	7 %	7 %	9 — 11	9 — 11	...	...
12,500	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	8 %	10 %	12 %	22 — 23	21½ — 22½	22⅝	21½
3,000	Do. do. do. 7% Pref.	10	7 %	7 %	7 %	18½ - 19½	18½ - 19½	...	...
50,000	Do. do. do. 4½ Mort. Deb. Stock	Stock	4½%	4½%	4½%	110 - 115	110 —115	...	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	10 %	10 %	10 %	21 — 22	21 — 22	21 9/16	21¼
300,000	Do. do. do. 4 % 1st Mort. Debs.	100	...	...	...	102 —106	102 —106	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	2⅞%	2⅞%	3¼ %	10 11/16 10 13/16	10 11/16 10 13/16	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5 %	5 %	15½— 16¼	15½ — 16¼	...	...
37,350	Telegraph Constn. and Maintce., Ltd.	12	15 %	15 %	15 %	35 — 38	35 — 38	36½	36
150,000	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	5 %	102 —105	102 —105	...	...
540,000£	Waterloo and City Railway, Ord. Stock	100	...	...	...	135 —138	135 —138	137	136⅜

† Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

*** Birmingham Electric Supply Company, Ordinary £5 (fully paid) 10⅜.**

House-to-House Company, 4½% Debentures of £100, 106—108.

Kensington and Knightsbridge Electric Lighting Company, Limited Ordinary Shares £5 (fully paid) 16½—17; 1st Preference Cumulative 6 %, £5 (fully paid), 8—8½. Debentures, 105—107. Dividend, 1897, on Ordinary Shares 10 %.

* From Birmingham Shar List.

London Electric Supply Corporation, £5 Ordinary, 3½—4.

*** T. Parker, Ltd., £10 (fully paid), 15½.**

Yorkshire House-to-House Electricity Company, £5 Ordinary Shares fully paid, 8—8½. Dividend for 1896—6 %.

Bank rate of discount 4 per cent. (April 7th, 1898).

SOME RECENT IMPROVEMENTS IN ACCUMULATORS AND THEIR APPLICATION TO TRACTION ON COMMON ROADS.*

By J. T. NIBLETT.

(*Concluded from page 522.*)

Probably no individual type of secondary cell will be found to answer for the very varied and ever-increasing purposes to which this class of apparatus is now being applied, and it follows that some form of specialisation must occur.

For central electric light stations, or for such work as levelling up the loads on electric tramways, where moderately constant work is required, a battery whose weight is large, or whose bulk is great, may be safely used. For self-contained electric light installations, weight and space occupied by the battery is of some moment; and where intermittent charging only is resorted to, absence of local action is desirable. The battery, under these circumstances, may have to stand idle for considerable periods, and it would not do for it to lose its charge while thus waiting. For traction purposes, where charging each day, or even several times per day, may be practised, local action is not such an objection, and the loss sustained thereby may be neglected. For some forms of vehicles, such as broughams, dog-carts, tricyles, and the like, which may be only occasionally required, and may have considerable waits between the periods of use—waits which may extend over days and even weeks—the absence of local action is essential. A fifth class of apparatus in which storage batteries are now playing a most important part is that of self-contained portable electric lamps, so largely used for medical and other purposes. In this case absence of local action, lightness, and compactness, together with great mechanical strength, is absolutely essential. In many cases such lamps are required to hold their current for many months, and this can only be obtained where there is little or no local action. Again, as the plates used in these small batteries are of small dimensions, the form of construction may be such as is not permissible in any other class of apparatus.

* Abstract of paper read before the Self-Propelled Traffic Association, Liverpool Centre, on March 29th.

"Local action," it may be explained, is the term given by electricians to that frittering away of energy which frequently occurs while a cell is at rest. This wasting is experienced in nearly all forms of primary cells, and in many types of secondary cells. In the case of secondary cells it is due to the establishment of voltaic couples between the metal support and molecules of lead salt when in the presence of sulphuric acid and water. This troublesome complaint leads to the destruction of the peroxide and the formation of sulphate of lead, and it not only reduces the capacity of the cell, but it frequently leads to its ruin. In the Planté cell, with its large metal surface and thin layer of active material, local action is far more prevalent than in the Faure, with its comparatively smooth and small metal surface and thick masses of lead oxide.

To accurately test a storage cell is no easy matter, and unless great care is exercised very fictitious results may be obtained. A laboratory test as a preliminary may be very well, but for practical results such tests should not be relied upon. Testing under actual working conditions, and for an extended period, is the only reliable means of ascertaining the capabilities of cells intended for traction work.

To obtain a capacity test by discharging through a constant resistance, noting the fall of current and potential, is quite easy of manipulation, and is much used when comparative tests only are required. A more reliable method, however, is to discharge at a constant current, stopping when a prescribed fall of potential occurs. For traction work, where a uniform output for a given number of hours is required, it is very much the best plan to take the capacity of the cell in terms of watt-hours. Under these circumstances the discharging rate in watts must be kept constant. Testing for local action, noting the effect of high rates of charge and discharge, are more serious matters, and require careful manipulation.

The internal resistance of a cell depends upon the total active surface area of the opposing plates, the nature of the electrolyte and its condition and temperature, and the distance between the plates.

There are many methods for determining the internal resistance of batteries. If the cells be as nearly as possible of the same dimensions, capacity, and state of charge, then two cells may be placed in opposition (poles of like polarity joined together) and their joint resistance may be measured by the ordinary Wheatstone bridge method. If the cells be exactly similar, then one-half the resistance indicated will represent the resistance of each cell.

A far more reliable and accurate means of ascertaining the internal resistance of cells is the differential method, as expressed by the following formula:—

$$r = \frac{D - D'}{D} R$$

where r is the resistance required, D and D′ are the values of deflections obtained on a high-resistance sensitive galvanometer, and R expresses the value of a small but known resistance, used as a shunt.

When making tests by this method, a high-resistance potential galvanometer should be used, and one whose scale readings are either of uniform value, or whose tangents are strictly proportional to the angle of the deflections. To determine r we have to obtain a deflection, D, when the cell is on open circuit, and then obtain another reading, D′, when the cell is shunted by R, then by the formula given the internal resistance may be ascertained. The shunt resistance, R, should be small in comparison with the galvanometer coils. Good results may be obtained if the resistance of the galvanometer is, say, 5,000 ohms, and the shunt not more than 1 to 5 ohms.

The total current, or energy capacity, of a storage cell is the maximum amount of current or electrical energy which it is capable of storing, without reference to any loss that may occur by it being allowed to remain idle, nor does it take into account the rate or manner of its discharge.

The working current, or energy capacity, is that amount of current, or electrical energy, which can be obtained from the cell at any specified rate of discharge. When estimating this, the discharge is always stopped as soon as the cell ceases to do useful work. The working capacity of storage cells may vary between very wide limits.

The absolute current, or energy efficiency, of an accumulator cell is the ratio between that amount of current or energy put into it and that obtained by a total discharge, without reference either to its rate of charge or discharge, or to the time allowed to elapse between these operations.

The working current, or energy efficiency, of a storage cell is the ratio between the value of the current or energy expended in the charging operation, and that obtained when the cell is discharged at any specified rate.

In a lead storage cell, if the surface and quantity of active material be accurately proportioned, and if the discharge be commenced immediately after the termination of the charge, then a current efficiency of as much as 98 per cent. may be obtained, provided the rate of discharge is low and well regulated. In practice it is found that low rates of discharge are not economical, and as the current efficiency always decreases as the discharge rate increases, it is found that the normal current efficiency seldom exceeds 90 per cent., and averages about 85 per cent.

As the normal discharging electromotive force of a lead secondary cell never exceeds 2 volts, and as an electromotive force of from 2·4 to 2·5 volts is required at its poles to overcome both its opposing electromotive force and its internal resistance, there is clearly an initial loss of 20 per cent. between the energy required to charge it, and that given out during its discharge. The normal discharging potential seldom exceeds 2 volts, and as this pressure is continually being reduced as the rate of discharge increases, it follows that an energy efficiency of 80 per cent. can never be realised. As a matter of fact, a maximum of 75, and a mean of 60 per cent., is the usual energy efficiency of lead-sulphuric-acid storage cells.

What the ordinary commercial man will be most interested in are tests which give him reliable information at to the cost of the up-keep and life of the battery; also data as to the initial cost, and as to the mode of it doing its work. Such information cannot be obtained in a laboratory, and has to be obtained by actual trials.

We have already shown that no one type of cell is capable of doing all the very varied kinds of work accumulators are now called upon to do. Before building up a battery, it is, therefore, wise to ascertain definitely the class of work it is intended to do, and construct accordingly.

Perhaps a short description of one or two of the present applications of secondary batteries for propelling motor cars will best serve to show the usual method of practically dealing with them.

In this country, the vehicles put upon the London roads by the London Electrical Cab Company may be looked upon as a pioneer enterprise, and its development will be watched with the closest interest by all those concerned.

The battery used is a special Faure-King type, and is supplied and maintained under contract by the E.P.S. Company. The plates used are thin, and to prevent the active material being "washed" out, the surfaces are covered with a layer of silicated asbestos held in position by thin sheets of perforated vulcanite. The whole of the cells are mounted in a tray, which is slung underneath the cab by four suspending links. These links are supported by springs under compression, and, as an extra safeguard against vibration, the ordinary carriage springs again support the battery tray. The total weight of the battery is 14 cwt. The total weight of the complete vehicle, including driver and its full complement of passengers, is approximately 30 cwt.

The battery consists of 40 cells, and, as previously stated, it weighs complete about 14 cwt. The capacity of each cell is 170 ampere-hours at a normal discharging rate of 30 amperes. The electrical pressure at the battery terminals is 80 volts. Thus the battery has a storage capacity of 13,600 watt-hours at a discharging rate of 2,400 watts, or about 3⅓ electrical H.P. When fully charged the battery is said to be able to run the cab a distance of 50 miles over the ordinary London streets. The mean current drawn from the battery when on a level road is 30 amperes, on rougher road from 40 to 45 amperes is required, while climbing steep gradients the cells are called upon to give as much as 120 amperes. The motor, although constructed to give a normal output of 3 H.P., is capable of a maximum of 4 H.P. without unduly heating, so that a margin of 25 per cent. is obtained for eventualities.

In New York some electric hansom cabs have recently been put on the roads. The cabs are made by the Electric Carriage and Waggon Company. In some respects they resemble our London hansoms, but the vehicles are fitted with four wheels instead of two. The back wheels are used for steering and the front for driving. The chief feature of this cab is that two motors are used, one for each of the driving wheels. By employing two motors, various variations of speed can, of course, be obtained by running them in parallel or series; and by having each wheel under separate control, quicker turning power of the vehicle can probably be obtained. This is doubtless the object the designers of the New York hansoms had in view, although it is very problematic if any very real advantage is gained by such an arrangement, unless it be used in heavy vehicles such as coal lorries.

The New York cabs are said to weigh 3,000 lbs. Each motor develops 1½ H.P. with 75 volts, and at a speed of 800 revolutions per minute. This represents a speed of 8 miles per hour for the vehicle. The battery used consists of 44 cells placed in trays containing 11 cells in each. The four sections are placed in a receptacle in the rear of the vehicle. No loose terminals are used, contact between the sections and other parts being established by means of plates and contact springs. Each cell contains three plates of the chloride form, and they have a useful capacity of 100 ampere-hours when discharged at 21 amperes—the normal rate. The whole battery weighs 900 lbs. Speeds varying from 4 to 15 miles per hour can, it is said, be obtained with varying battery discharges of from 12½ to 40 amperes.

L'Electrique Société Anonyme of Brussels have recently introduced an electrically propelled dog-cart. In this vehicle, and according to the usual practice, the battery cells are placed underneath the seats. 48 cells of the Planté type, having a capacity of about 75 amperes, are used. The total weight of the battery is 850 lbs. The motor is wound with the coils of the fields and armature in series, and it weighs about 260 lbs. A speed of 1,750 revolutions per minute is attained with a battery discharge of 21 amperes. The motor is connected to the driving wheels by reducing gear and chain bands, while differential movements of the driving wheels are obtained by the use of an intermediate clutch.

The dog-cart has four wheels, and is made to seat four passengers, including the driver. The carriage, including batteries, motor, and gearing, weighs, complete, about 2,500 lbs. The maximum speed is 10 miles per hour, and at this rate it is stated a distance of from 40 to 50 miles can be travelled with one charge of the battery.

As a means of regulating speed in a self-contained motor car, actuated by batteries, two methods are at present in vogue. The first is by splitting up the battery into sections by a suitable commutating arrangement, thereby putting the sections either in series or parallel, as required. The objection that may be raised to this plan is that the cells may be unequally discharged. A more practical method, and one adopted on the London cabs as explained, is using the battery as a complete unit, and obtaining the various speeds by commutating the coils in the fields and armatures of the motor. It is possible that some method may be adopted, by which the motor may be run at constant speed, while the speed variations in the car are obtained by suitable gearing. According to present practice the motor, when starting the vehicle, is running slowly, and therefore in its most inefficient condition. If the constant speed idea were utilised, the motor might be of smaller power, and it could also be run at a higher and more uniform efficiency.

For the Paris electric cabs Messrs. De Puydt & Poncin, of Birkenhead, are supplying some special motors, which appear to compare favourably with those used in our London cabs. It is stated that these motors, which weigh only about 170 lbs., will develop 8·5 H.P. for 20 minutes, or 4·5 H.P. for continuous running, without any undue heating or sparking. The normal speed is given as 1,700 revolutions per minute, and a commercial efficiency of 81 per cent. is said to be obtained.

As regards the prevailing method of connecting the motors to the driving wheels by the system of gearing, probably with our present knowledge it is the best that can be done. Some way of dispensing with gear and running direct will probably be devised. If this could be done, not only would it lead to great economy in working, but it would greatly add to the comfort of the passengers. When riding, for instance, in one of the London electric cabs, in addition to the hum of the motor, which is not at all unpleasant, one's ears are assailed by the clanking and rattling of the gearing and chain. If direct running or some more silent method of gearing could be devised, it would be a desirable improvement. Improvements in the wheel tyres will doubtless be made, and such improvements would tend to reduce road friction, and thereby save power or give increased speed. They would also reduce the depreciation in the working parts and give the battery a better chance.

Methods of electric locomotion on common roads present enormous possibilities. Electrically-propelled omnibuses, broughams, dog-carts, and light parcel delivery vans may now be seen running along our thoroughfares. There is no reason why the same plan should not be adopted for driving vehicles for the cartage of goods generally. In the latter case appearance need not be studied to such an extent as in the passenger-carrying conveyances; therefore, in this case the electrical engineer would have a freer hand, and better results might be anticipated.

Methods of recharging will have to be seriously considered. There seems no reason why, in all our large towns, charging centres should not be established. The ordinary cab is stationary a great part of the day, and there seems no valid reason why the charging operation should not be rendered so simple that a cabman of ordinary intelligence could easily perform it. With an "in-and-out" electricity meter placed on the vehicle in a convenient position on the battery circuit, the driver could see at a glance how much energy had been put in and taken out of his battery; therefore, would know

when a recharge is required; also, when charging, by reference to the meter, he could see when his battery is satisfied. Such a measuring instrument, with the small range required, need not be an expensive addition. A supply system, worked on the penny-in-the-slot principle, could easily be arranged. The battery, of course, would not be removed, but would be connected up to the source by suitable flexible mains. Under these conditions the driver could buy his supply of electricity much in the same way as a carman can now buy fodder for his horses.

The form of battery required for driving a self-contained motor car over common roads may need to be of a different nature to that required in cars running on a permanent way, where the tractive force remains more nearly constant, and where there is less jolting and vibration. Possibly some form of mechanically solid cell with a Faure type negative and a Planté type positive element will fulfil the requirements.

As to the probabilities of the self-contained electric motor car comparing favourably with horse haulage, this will entirely depend upon its economic aspect. However great the convenience of electric haulage, however great its reliability, ease of manipulation, sanitary aspect, and general convenience, the question as to whether it is best or not has still to be satisfactorily answered. In its present experimental stage trustworthy figures of the daily or weekly cost of up-keep cannot be expected. It is only by taking the average expenses incurred during months or years that anything like an accurate estimate can be arrived at. The initial cost and cost of maintenance of the batteries employed will, we believe, be the controlling factor. Whatever turn the idea of electrically propelled motor cars may take, it must necessarily always involve the use of some apparatus for storing and giving out electrical energy.

The modern secondary battery leaves very much to be desired, but still there are several very good batteries for this purpose obtainable, and these may serve to tide the electric traction man over the period intervening before the advent of the ideal cell which we all wish to see.

ELECTRIC LIGHTING OF MAIL COACHES.

Some interesting particulars have been published concerning the electric lighting of German mail coaches. The *Elektrotechnische Zeitschrift*, which discusses the subject in a recent editorial, states that the 15-volt lamps employed for this purpose are of 12 candle-power and are replaced by others after being in service for 200 hours, notwithstanding the fact that the filaments are still intact. The glass bulbs are tolerably larger in order to delay the blackening of the bulbs as much as possible. As the lamps are arranged in suitable positions before the Post Office officials, a greater illumination of the working places is obtained than with intensive gas burners suspended from the roof behind the sorters.

In the case of the 12-metre mail coaches a battery of 32 cells of the Boese type is used, whilst the coaches 10 metres long are equipped with 16 cells arranged in four boxes. The weight of the 16-cell battery, which has a capacity of 120 ampere-hours, is 184 kilogrammes; but in a newer type with the number of plates reduced from 9 to 7 per cell, the weight has been diminished to 172 kilogrammes.

At the present time the re-charging of the batteries is effected at 18 depôts, and three further charging stations are now being erected. Where the railway administration possesses a charging station of its own, the batteries are connected in series of 16 cells, or from boxes to omnibus bars between which there exists a pressure of 45 volts. If the current is obtained from municipal supply works, the pressure as a general rule ranges from 100 to 110 volts, and in some cases, as at Breslau, it amounts to 220 volts. In these instances a lot of useful energy would be dissipated in resistances unless a larger number of cells were simultaneously charged in series. The batteries delivered at a charging station are, however, not all in the same condition, and for that matter it would be impracticable to select and group them according to their electrical condition. As a result the inconvenience arises that highly exhausted batteries do not receive a sufficient re-charge, whilst those slightly exhausted receive too much; hence the life of the plates is injuriously affected.

In order to overcome this difficulty, Post-Inspector Argrath has suggested a method whereby each battery, where the pressure between the bus bars at a charging station is too high for the purpose, only receives a charge of current at a pressure of about 45 volts, or at that pressure required by the condition of the battery. This object is attained with a current at a pressure of 100 volts by the employment of a middle bus bar between which and the outer bars the batteries are connected in a manner similar to the Edison three-wire system. If the number of batteries on both sides of the middle bar is the same and the batteries are all in the same condition, only about 5 volts has to be absorbed in each charging conductor by the rheostats, which must be used in any case for each battery. Should, however, these conditions not be fulfilled, the pressure on one side of the middle bar will be higher than that on the other unless a special means of artificial compensation is provided. This is now attained by the use of a main rheostat which can be arranged on one or the other side of the system. This rheostat is placed parallel to the batteries on the side of higher pressure, and so arranged that the requisite compensation is effected. When the current available has a pressure of 200 volts, it is provided that the above arrangement shall be doubled.

It has been possible to ascertain some figures concerning the cost of lighting 627 mail coaches in this manner from nine charging stations, which have been in operation for over a year. After providing 4 per cent. for interest on capital and 10 per cent. for redemption (20 per cent. for the batteries), the lamp hour with a 12 candle-power lamp works out at 3·52 pfennige (·42d.) This compares with 4·50 pfennige (·54d.) in the case of gas lighting, showing a difference of nearly one pfennig in favour of electrical illumination.

ELECTRICITY IN CHEMICAL WORKS.

Although power in chemical works does not occupy so important a position as it does in other industries, for instance in the textile industry, where the whole of the transformation is effected by mechanical means, it, nevertheless, plays an important part in numerous subsidiary operations, such as grinding, pulverising, pumping, compressing air or other gases, actuating cranes, hauling, &c. And so great is the competition in all chemical manufactures, that it becomes a matter of prime importance to determine what shall be used as a source of energy, whether steam, gas, electricity, or water. At a recent meeting of the Manchester Section of the Society of Chemical Industry, Dr. Bowman examined this question to some extent, but we do not think that he has dealt with the subject so exhaustively as it deserves. He has much to say regarding the use of steam, and gives some very interesting figures respecting the efficiency of this agent. The efficiency of the gas engine is also considered briefly, and data are given, but electricity is dismissed as impracticable, and those who read the paper are not likely to be convinced because the statement is merely supported by Dr. Bowman's opinion. If the paper were to be a useful contribution to an important subject, comparisons between gas, steam, water, and electricity should be properly drawn, data should be given for each source of power, which should be entirely comparable. This Dr. Bowman has failed to do entirely, and the matter is in the same position as it was before he touched it.

Of course, it is advisable to avoid mechanical operations as much as possible in chemical works, and when they are necessary the machinery should be simple. Chemical works abound in dust, dirt, gases, and liquids which injure the machinery, and we agree with Dr. Bowman that it is advisable to use the very simplest forms of engine which can stand the wear and tear to which they have to be subjected. Then again, chemical works usually cover a large area of ground, and operations are rarely simultaneous, and the general practice is to rely upon small independent engines—a very bad plan indeed, for even under the best conditions the steam engine is a wasteful machine. In large chemical works power has to be distributed over miles of pipes exposed to the condensing action of the air, which of itself accounts for a very large percentage of inefficiency. Indeed, Dr. Bowman himself admits a doubt whether, in many of the small engines, more than 5 per cent. of the power originally in the fuel is actually used. In addition to all this, steam is not a good vehicle for obtaining power, because it can never be a perfect gas unless absolutely dry, and the moment it begins to expand—which it must do if worked economically—it ceases to be a dry gas.

Although these considerations seem to point directly to electrical distribution as the most economical method of working a chemical factory, Dr. Bowman contends that it is almost impossible, for dust and gases have a marked effect on conducting wires and electric motors. He says that lead-covered wires, even with a coating outside, are eaten through in a short time, and except where motors can be enclosed in special rooms or boxes, and conducting wires kept out of reach of corrosion, electric distribution of power is not suitable for chemical works. It seems to us that this form of distributing energy should not be so jauntily dismissed. It is quite true that there are many difficulties in the way; a manufacturer does not like to risk having his installation worn out by corrosion shortly after he has laid it down. But have we probed all the possibilities? We wonder in how many instances electric distribution has been tried with such disastrous consequences as Dr. Bowman seems to imply would necessarily follow. Surely it is possible to place the generating plant in some part of the works, which, as Dr. Bowman says, are always large, where it can be safe from corrosive gases; or the construction of a special building, with double doors and windows, ought not to be impossible. If either of these two courses can be successfully observed, then the problem of protecting the wires ought not to be insurmountable, whilst the motors themselves could surely be enclosed in special rooms or boxes. We do not think that Dr. Bowman has made out a bad case against electric distribution in chemical works, for he has simply dismissed it with a meagre statement of difficulties and a strong statement of his own opinion.

On the other hand, he concludes his paper with a remark that electric distribution can best be applied in chemical works to lighting. He says that at least twice the quantity of light can be obtained by the arc lamp than by burning gas or even Wells's light, and, finally, he says that to compete with steam as the motive power, electricity must be supplied at not more than ¼d. per Board of Trade unit, or half this cost to compete with gas. These latter, however, are statements which are entirely unsupported by comparative data, and we are invited to accept Dr. Bowman's opinion. Thoughtful people will require a good deal more than that, and we hope that the attention of electrical engineers will be aroused by these statements, and that some comparative data may be obtained from an actually working installation.

As regards electro-chemical processes, the conditions are somewhat different from those obtaining in chemical works generally; but we shall await with interest Dr. Bowman's promised paper on the subject. We hope that it will be more copiously illustrated with facts than his present paper.

ELECTROLYTIC TREATMENT OF SLIMES.

If we were asked what among the applications of electricity is the one which seems the most remarkable, there would be a majority in favour of wireless telegraphy, which, however, has not yet come into general practice, and is only just emerging from the experimental stage.

The admirers of X rays, and those of the utilisation of the Niagara Falls energy, would be numerous; but for an electro-chemist, and especially an electro-metallurgist, the solution of the problem of the economic extraction of gold from slimes, that clayey mass through which no solution can percolate, looks as if it were most decidedly the greatest achievement accomplished in the electrical world.

Mr. Charles Butters in his valedictory address to the Chemical and Metallurgical Society of South Africa, of which he is the president, described the treatment of the slimes, in which, up to the present, large treasures were buried and considered as lost for ever.

Ten years ago, the great question was to extract the gold from the heaps of tailings which were lying as barren sands. To-day, it is the turn of the slimes, with this difference, that gold can be recovered from tailing solutions by means of zinc, although not so well as by the electric current, while the precipitation of gold from an extremely weak cyanide solution is quite an easy operation by electrolysis, but cannot be effected by zinc shavings.

This question is of so much importance to the mining industry that it marks an epoch in the metallurgical world that is well worthy of consideration.

It was only the production of such gold-bearing material as tailings, and the enormous quantities in which they were produced that brought the necessity of the treatment of tailings before the public in a very marked degree; and in the same manner the enormous production of slimes, their storage and value, demanded an economic method of treatment.

It was found that if they were allowed to be deposited in dams for a comparatively short time, even for a few days, decomposition of the pyrites took place, and the question of their treatment directly as received from the mill thus became a subject for study. These researches have successfully resulted in the working out of a practical method which consists essentially in the coagulation of the slimes in battery water, by means of lime, their concentration by spitzkasten, and final settlement in continuous overflow vats or pits. The coagulation of the particles in clayey soils in agricultural operations by the addition of lime has long been known and practised, and the use of lime for the flocculation and precipitation of the slimes suspended in battery pulp is but another adaptation of the same principle.

General Features of the Slimes Problem.

"In slimes, says Mr. Butters, we found a substance which could not be backed, or through which the solution would not percolate, but which we were obliged to wash per decantation. With decantation, the washing of the material takes place by dilution, one wash does not displace another wash, but simply mixes with it; and since the amount of solution or wash which this clayey mixture retains is from 40 to 50 per cent., the amount of dilution necessary to extract a satisfactory percentage of the gold necessitates the use as washes of from 6 to 8 tons of liquid per ton of slimes treated. Consequently, in sand treatment, where 4 dwts. are extracted from 1 ton of sand, with 2 tons of solution, the average value of the solution is 2 dwts.; while in slimes treatment, if 4 dwts. are extracted from 1 ton of slimes, the average value of the solution would be 12 grains. In the case of the sand, the value of the first solution leached off might easily be 6 dwts., while with slimes, the first solution would probably not be over 1 dwt. The result is, that in the latter case you have a very large volume of much diluted solution to deal with, and at the same time the slimes retain a moisture nearly their own weight of solution. In order, therefore, that slimes may be economically treated, it is necessary to use a very dilute solution of cyanide, so that too much cyanide may not be lost with the residues when discharged, and that too much may not be decomposed during treatment. How to obtain gold from this solution presents an entirely new problem to the metallurgist. Dilute solutions containing from 0·01 to 0·001 per cent. of cyanide, and from 6 to 24 grains of gold per ton, had not hitherto been successfully handled."

The Solution of the Gold.

"The dissolving of the gold in fresh slimes is a comparatively simple matter in comparison with the dissolving of the gold in accumulated slimes. In fresh slimes, there are usually very few reducing or oxygen-consuming compounds, while in accumulated slimes there can be various substances which will absorb oxygen; and if we wish the cyanide gold-dissolving solution to act, oxygen must be present. In old slimes, decomposing organic matter, arising from different sources, as well as the various products of the decomposition of pyrites, are always present; all these substances have, in common, the property of absorbing oxygen in a more or less degree. Therefore, during the operation of dissolving the gold in old slimes, oxygen must be constantly supplied.

The principal of oxidation of the reducing substances in slimes by means of aeration, was put into practical use by Mr. W. A. Caldecott, who has given the reasons that render this operation specially necessary in the treatment of accumulated or acid slimes. This operation was first carried out at the Robinson slimes plant by the introduction of atmospheric air through a perforated pipe in the bottom of the vat containing the charge of pulp undergoing agitation. After preliminary oxidation of the pulp had taken place, in order to lessen cyanide consumption, cyanide was added, and aeration continued. It was found that the gold dissolved as readily by this method as in the case of fresh slimes."

The Precipitation of the Gold.

In the foregoing operations the ordinary methods of metallurgy have been reversed. In every other metallurgical operation, successive concentration is the means by which we finally obtain the metal for which we are working; but in this case we pursue the opposite course. The final operation of winning the gold takes place from a grade of material worth less per ton than was the material with which we started. We have simply changed the physical conditions of the gold from the state of a solid into that of a liquid, and it is with this diluted liquid that we have now to deal. Precipitations of metals from solutions present many curious and interesting problems, and one of these is, that with the same re-agents, it is very much more difficult to produce perfect precipitation from a very dilute solution than from a concentrated solution.

In electrolytic precipitation we have a different set of laws governing the electro-deposition of metals from those which operate in chemical precipitation. In the course of our experiments on the precipitation of dilute cyanide liquors, we have tried many methods of precipitating solutions containing 6 to 12 grains of gold per ton, but failed completely with such dilute liquor; whereas the same methods acted perfectly on 5 dwts. or 10 dwts. solution. With a solution of gold down to 6 dwts. per ton, which is about one part in 100,000, it would be natural to think if it was one part in 100,000, or one part in a million, or one part in 10 millions, there would not be a very great difference in the resistance of such very minute proportions of dissolved gold to precipitation, whether by electromotive force or by chemical reaction; but the difference between the action of a liquid containing 6 dwts. per ton and one carrying 6 grains per ton is most marked, both in chemical precipitation and in electrolytic deposition. In general, we have found that we could effect the precipitation of the gold in these dilute solutions best, and most economically, by means of electrolysis.

The principal points in electrolytic precipitation that it is desirable to study are the amount of current per square foot of anode and cathode, and the time the current is exerted, taken in conjunction with the value of the solution. One of the first points requisite in the electrolytic deposition of gold is that the liquor shall contain no solid matter; that is to say, that it will be absolutely clear.

The liquor from accumulated slimes contains a considerable amount of iron and lime salts in solution, and the settlement of the fine clayey particles is retarded. This may, possibly, also be due to the organic matter which it contains.

Other substances in the liquid which affect the surface of the cathode are those salts which are in solution upon entering the box, and are there deposited on the large surface exposed, or are electrolysed. Lime, which has been used for settlement, and also to neutralise acidity, is in the form of carbonate of lime, sulphate of lime, or hydrate of lime. This precipitates partly as carbonate and partly as sulphate upon the anodes and cathodes, more especially on the former, and is precipitated by means of the electrolytic current. Then there are the products of the decomposition itself, which (in the case of iron salts resulting from the decomposition of the pyrites in the ore) are separated in the form of Prussian blue and hydrate of iron. These, again, are the products of the decomposition of the anode plates.

The clearness of the solution depends largely on the solution of the anodes. The iron plate anode in use to-day in the Siemens and Halske boxes, with properly proportioned current, is a very perfect anode, easy to be obtained in any quantity, and as easily manipulated and secured in the boxes. With a current density as low as 0·03 or 0·04 ampere per square foot, very little decomposition of the iron anode takes place. An anode $\frac{3}{8}$ths of an inch in thickness and with a current density of 0·035 ampere per square foot, should last for five years, and possibly much longer. There seems to be a limit of current density up to which an iron anode will show very little corrosion; but beyond that point, oxidation seems to take place more rapidly than the proportionate rise of current density would indicate. Where the division and tension of the current has been very carefully studied and regulated, very little decomposition of the anode need take place.

With the peroxide of lead anode, which was discovered by Mr. Emile Andreoli in the early part of 1895, practically no corrosion of the anode takes place, and although, up to now, this anode has only been used in a small way, one is confident that its introduction into this country on a large scale would prove satisfactory. With perfectly filtered conditions, and with peroxide of lead anode working with fresh slimes, and by watching carefully the amount of lime added to the slimes, there should be very little trouble in maintaining a perfectly clear anode surface for the plating of the gold.

The subject of the production of suitable anodes for precipitation of gold from cyanide solutions is probably not exhausted, but the field has been very thoroughly explored by able electricians and chemists, and beyond the two anodes mentioned, we do not know of any that will fulfil the required conditions. The anode has attracted a good deal of study, but the subject of the cathode is not less interesting and important. Many substances have been tried, which have performed their functions more or less completely. Lead has been used in thick plates, in thin sheets, in ribbons or strips, and in the form of shavings, while zinc has been used in the form of amalgamated plates and as shavings; amalgamated copper plates have similarly been tried, together with iron plates and various other forms of iron; and the same with mercury. Zinc, copper and iron, in various forms have been utilised by Mr. Andreoli for this purpose. Mercury is in use in the United States in the Pelatan-Clerici process; on these fields, at present, lead strips and lead shavings are in use, and zinc shavings are used by Mr. Bettel at the Comet. Each of these various cathodes have their peculiar advantages. Lead strips are used everywhere in the plants using the Siemens process except at the Central works, where part of the boxes are charged with lead shavings.

We may look upon the slimes treatment as it has been developed in this country by the members of this society as a new metallurgical process, which will be adopted all over the world, and we think that its main features will be practically retained. The use of lime for settlement, the use of spitzkasten for collecting, tanks for "natural settlement," dissolving the gold by means of agitation or centrifugal pumps, the decantation of the liquid, and the precipitation by electrolytic method, are, probably, permanent features, which in detail may be modified to some extent, but which will remain with us.

SUBMARINE TORPEDO BOATS.

A paper dealing with the subject of torpedo boats and their influence on torpedo boat architecture, by Captain W. H. Jaques, was presented at the recent conference of the Institution of Naval Architects. The author, after referring to the four preliminary submarine boats built in the United States under the direction of Mr. John P. Holland, proceeded to describe the *Plunger* and the *Holland*, which are now receiving considerable attention in that country.

The boat constructed by the Holland Company for the United States Navy Department was named the *Plunger* by the Department, and was launched August 7th of last year at the constructor's yard in Baltimore. She is the fifth one designed by Mr. Holland, and is 84 feet long, of circular section, 11 feet 6 inches diameter, surface displacement 149 tons, submerged displacement 165 tons, with a reserve buoyancy of about a quarter of a ton. The guaranteed speed is 15 knots on the surface and 14 knots with her steam machinery while awash, with 1 foot of the turret above the water. Her totally submerged electrically running speed must be 8 knots for six hours.

There is a turret amidship with 4 inches of protection and a superstructure for a fair water. Two down-haul screws have been added, although they are not considered by Mr. Holland a requisite of the system. There are two openings in the nose-piece through which service-torpedoes are to be discharged. In addition to hand-gear for horizontal steering and diving, there are automatic devices for maintaining submergence at predetermined depths. A camera lucida has also been fitted. The hull has been constructed to admit a submergence of 75 feet. Some of the water-tight compartments serve as water-tanks; others contain oil fuel; others are employed for compensating discharged weights. A special device compensates for the oil consumed. There are four rudders, two for steering horizontally and two vertically, controlled by automatic devices. For running on the surface or awash, steam generated by petroleum is employed, while electricity from storage batteries is used under water. There is one water-tube boiler of the Mosher type of 3,000 square feet heating surface, fitted with a system of oil fuel capable of consuming 2,000 lbs. of oil per hour. There are two main, vertical, triple-expansion steam engines of 600 H.P. each, and one auxiliary of the same type of 300 H P. The electric machinery is composed of one main motor of 70 H.P. for propelling the boat when submerged, operating either the side or centre shaft, or used as a dynamo for recharging batteries. There are additional electric motors for operating down-haul screws and performing other services as required. Air for tank and ventilation service is supplied from commercial reservoirs. There are special fittings for closing smoke pipe and air ducts quickly before submerging, and the tank operations are very simply controlled by Kingston and compressed air reducing valves. The *Plunger* has three propellers (in addition to the down-haul screws), any one, or all of which can be operated by either steam or electrical machinery.

The author then referred to the *Holland*, a smaller and similar type of boat, and proceeded to suggest the possibilities of such craft to take the place of second-class torpedo boats on battleships, and of semi-submerged boats of almost any dimensions, having armour enough above water to afford ample protection, at the same time protecting all the rest by water. In conclusion, he pointed out that the great need of the hour for harbour and coast defence is a small torpedo boat that can be submerged, having within it a storage battery of sufficient power to give it a submerged range of a few hours, with 9 or 10 knots surface speed, and from 6 to 8 knots submerged.

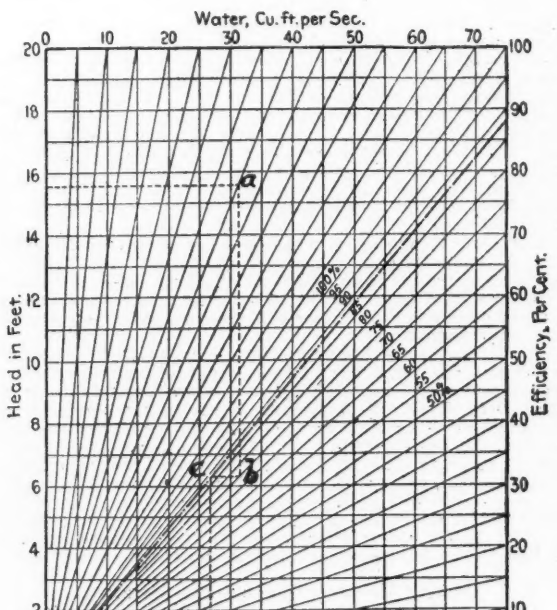
WATER POWER DIAGRAM.

The accompanying diagram, for which we are indebted to the *Electrical Engineer* of New York, is due to Mr. O. H. Landreth. It is a graphical representation of the formula, H.P. $= \frac{\text{H Q D E}}{500}$, where H is the effective head in feet, Q is the quantity of water in cubic feet per second, D is the weight of a cubic foot of water = 62·4 lbs., and E is the percentage of efficiency of the wheel.

There are two sets of radiating lines from the left lower corner of the diagram. Those which pass to the top line are lines of supply; those to the right hand vertical line are efficiency lines, except the dotted line near the 90, which is a conversion line for horse-power. To use the diagram there is assumed as an example a head of 15·6 feet, at which a supply of 40 cubic feet per second is used in a wheel of 75 per cent. efficiency.

The following is the mode of using the dotted line showing the procedure: From the left vertical scale of head in feet, viz., at 15·6, draw a horizontal to touch the inclined line from the 40 cubic feet division on the top scale. From this point of intersection, *a*, drop a vertical to the inclined line from the 75 per cent. division of the efficiency scale. From this second point, *b*, draw a horizontal to the conversion line. From this final intersection, *c*, a vertical line to the lower scale shows the horse-power, 53·2.

The conversion line is drawn at such an angle from the vertical as makes the tangent $= \frac{1}{2}(0{\cdot}1134)\ 75\ \frac{v}{h}$ where v and h are the numerical values of the vertical scale of head and the horizontal scale of



quantity, the ½ being introduced to make the scale of horse-power half the scale of the upper line of quantity, and the decimal 0·1134 being the coefficient in the formula H.P. = 0·1134 H Q E for horse-power on the basis of the weight 62·4 lbs. per cubic foot. For amounts of head and volume beyond the range of the scale, the figures may be used as though of tenfold value, or to any convenient other multiple, the final reading being similarly multiplied.

CARBON BRUSH-HOLDERS.

By ERNEST KILBURN SCOTT.

Part I.

Although Prof. Forbes first suggested using a block of fine grained carbon on dynamo commutators so long ago as 1885, practically nothing was done to develop the idea until about 1892. Since then, however, the carbon brush has rapidly pushed its way into favour until it threatens to oust the metal brush out of the field altogether.

As the published information on the subject is somewhat meagre, the writer proposes, in the following article, to give a few of the rules which govern the application of carbon brushes, and also to describe some of the leading types.

One point on which there is a lack of definite information is:—How many amperes per square inch of area of contact on the commutator should be allowed for carbon brushes? So far as the writer's experience goes, 40 amperes per square inch is a good average, but some makers employ as low as

25 amperes per square inch of area of contact, whilst others allow as much as 60 amperes per square inch. A good deal depends on the size of the machine, the density being usually lower in a small machine because it may be convenient to use standard sizes of carbons. On the large generators for the Waterloo and City Railway, for example, giving 450 amperes at 550 volts, a quite sparkless collection is obtained by five carbon brushes, each with an area of contact on the commutator of 2 inches long by 1 wide. This gives

$$\frac{450}{5 \times 2 \times 1} = 45 \text{ amperes per square inch of contact.}$$

The ordinary 25 horse-power tramcar motor geared at 4·8 to 1 to a 33 inches tramway wheel, usually takes 15 amperes, but it may be suddenly called upon for five times that amount. The brush has an area of $2\frac{1}{2}$ inches by $\frac{1}{2}$ inch. In the more recent motors there are two carbons, each $1\frac{1}{4}$ inches by $\frac{1}{2}$ inch, or a total of $1\frac{1}{4}$ square inches, and we see, therefore, that the current density is usually somewhere about $\frac{15}{1{\cdot}25} = 12$ amperes per square inch, but it may rise on an emergency to 60 amperes per square inch. No doubt there is sparking at the high loads, but the results taken over a long period are undoubtedly much better than if metal brushes were to be employed for the purpose, even if they could be got to work well with the armatures running both ways.

It is interesting to compare the above with what is allowed for ordinary gauze brushes:—On a large 180-kilowatt dynamo giving 1,500 amperes at 350 revolutions per minute and with a commutator 12 inches in diameter, the current was collected by 12 brushes each 2 inches by $\frac{5}{16}$ inch on face. They were arranged in three sets of four in each set and a space of about $\frac{1}{8}$ inch was left between adjacent brushes.

The contact density works out at $\frac{1,500}{3 \times 4 \times 2 \times \frac{5}{16}} = 200$ amperes per square inch. Again, a multipolar machine with series armature has five brushes, each 2 inches by $\frac{3}{4}$ inch, (1 inch face) to collect 1,150 amperes, $\frac{1,150}{5 \times 2 \times 1} = 115$ amperes per square inch.

With reference to the actual conductivity of the carbon itself, this will vary with the quality. The Carré brushes, made from lampblack, naturally give the highest conductivity, but they are expensive, and a commoner quality made from petroleum coke, tar, and plumbago, in about the proportions of 70, 20, and 10 parts, is now most generally used. The plumbago acts as a kind of lubricant.

Good conducting carbon specially supplied for the purpose will easily carry 60 to 70 amperes per square inch of cross section without getting unduly hot, but, of course, the current density may be higher in small section carbons than in those of large section, on account of the proportion of the cooling surface to the area being so much greater in the first case. The curve given in fig. 1 shows how the temperature varies

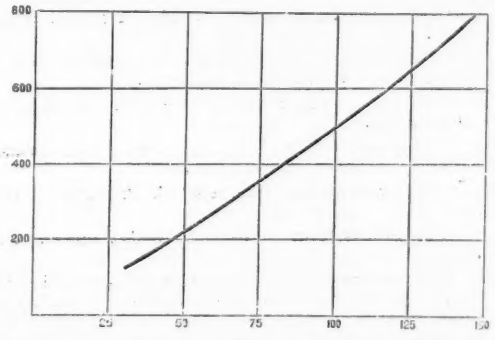


Fig. 1.—Curve showing the Heating of Carbon Brush pressed on to a Copper Plate.

with the current for a carbon block 1 inch square. In actual running it should be mentioned that the carbons are kept cool by the draught of air, and owing to the loose carbon dust the contact resistance is improved.

This matter of conductivity does not enter into the question so much with those brush-holders giving a metal support to the carbon to within, say, $\frac{1}{4}$ inch of the commutator; but where there is considerable overhang, as in the heavy Siemens type, conductivity becomes important. In fact, one objection to the use of carbon brushes on large dynamos, especially if they must pass a strict guarantee clause for efficiency, is that there may be an extra loss of 1 or 2 per cent. due to

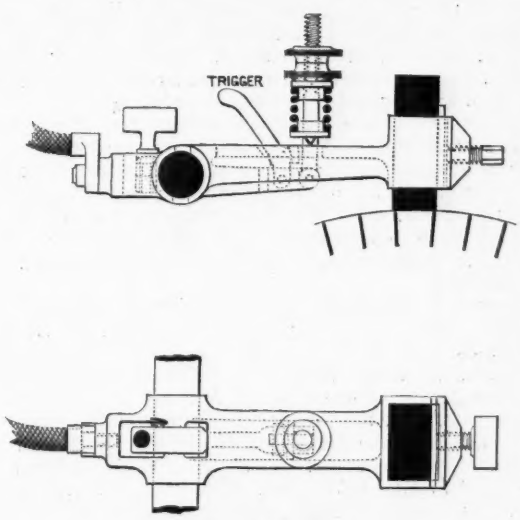


Fig. 2.—Plan.
Greenwood & Batley's Carbon Brush-Holder.

the brushes themselves. For example, the dynamos for the Leeds tramways were specified to have carbon brushes. The guarantee test for efficiency was made with metal brushes, with the result that Messrs. Greenwood & Batley, Limited, earned a good bonus, whereas if the carbon brushes had been used they would have only just scraped through. Fig. 2 shows the type of brush-holder (made of aluminium) in use on these machines, and it may be mentioned that the collection is as nearly perfect as possible, there isn't a sign of a spark however the load may vary.

One of the earliest recognitions of the fact that the use of carbon helped to stop sparking was made by Messrs. Crompton & Co., Limited, on some large machines which they supplied for aluminium reduction. The current taken off the commutator was considerable, and in order to reduce the

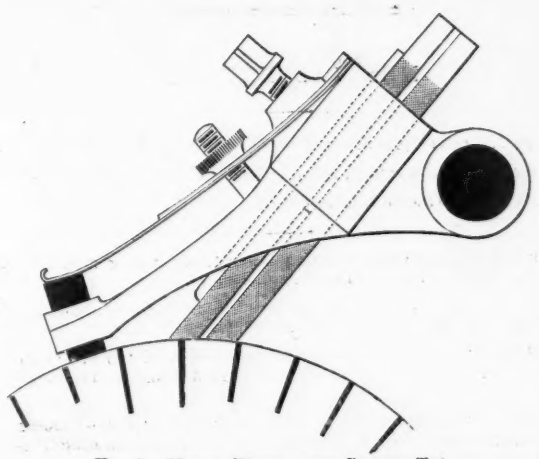


Fig. 3.—Metal Brush with Carbon Tip.

sparking as much as possible the ordinary metal brushes were fitted with carbon tips. Since then this method has been adopted on many other machines, especially where there were great variations in the load as well as large currents to deal with. A simple method of carrying the carbon block is shown in fig. 3. Arc lamp carbon may be used for the

purpose, or the little dovetail blocks clamped to the end of a flat spring.

Before going on to describe the various types of brush-holders it would perhaps be as well to enquire into the reasons why the mere substitution of a block of carbon instead of a metal brush improves the commutation. In order to do this properly, it will be necessary to consider for a moment the various causes of sparking. For, although armature reaction is the fundamental cause, there are other reasons, such as the impedance of the coil under short circuit, the time interval, and the thickness of the brush, which affect the question to a greater or less degree.

In the single core continuous current transformer the armature coils connected up to one commutator are paralleled by another set connected to the other commutator, and thus the magnetic effect of one is neutralised by that of the other. In other words, there is very little armature reaction and practically no lead to the brushes. Yet those who have worked these machines know that sparking is not necessarily eliminated.*

There is Messrs. Mavor and Coulson's combination of an auxiliary pole and the Sayer's reversing coils, also Messrs. P. R. Jackson's development of the latter. The partial reduction of the cross magnetising effect by an exaggerated chord winding as described in Mr. Mordey's paper on "Dynamos," and the thorough lamination of the poles (at right angles to the lamination of the armature core), as suggested by the writer, see *Proceedings of Institution of Electrical Engineers*, Vol. xxvi., page 598. Partial lamination of the field poles and shaping the poles away at the horns which tend to be strengthened by the cross magnetism, is, perhaps, the simplest method of reducing the lead.

All these arrangements are good as far as they go, but there are other causes of sparking which require to be attacked from the entirely external standpoint of the brushes themselves.

Any device which makes good commutation possible with a considerable lead on light loads, means that the machine can be successfully operated with little or no change of lead under varying loads.

Now, experiment has shown that this may be effected by placing an extra resistance in the circuit of the short-circuited coil. With a metal brush this can be effected by making it in several sections with a high resistance coil of small area (platinoid wire) between each. The heat waste and sparking caused by the difference of potential between adjacent segments respectively in contact between the advance and hinder sections of the brush is thus prevented.

(To be continued.)

NEW PATENTS.—1898.

Compiled expressly for this journal by W. P. Thompson & Co., *Electrical Patent Agents, 322, High Holborn, London, W.C., to whom all inquiries should be addressed.*]

8,019. "Improvements in or relating to alternating motors." A. J. Boult. (O. Patin.) Dated April 4th.

8,024. "Improvements in means or apparatus for electro-plating." H. V. R. Read and N. G. Thompson. Dated April 4th.

8,037. "Improvements in the manufacture of the peroxide elements of secondary batteries." D. G. Fitz-Gerald. Dated April 4th.

8,043. "Improvements in sockets or holders for incandescent electric lamps." J. W. Mackenzie. (Allegmeine Electricitats-Gesellschaft, Germany.) Dated April 4th.

8,054. "Improved means for fixing or fitting incandescent electric lamps into lanterns." J. Moores and H. O. Farrell. Dated April 5th.

8,059. "Improvements in apparatus for lighting miners' safety lamps by electricity." B. D. Williams. Dated April 5th.

8,070. "Improvements in electric trolly wire section insulators." W. Wood. Dated April 5th.

8,085. "Incandescent electric light decorations." A. A. Pollock. Dated April 5th. (*Complete.*)

8,097. "A medical electric generator or hot-air bath for the application of heat to the human body." A. E. Greville. Dated April 5th. (*Complete.*)

8,104. "Improvements in electrical measuring instruments." F. M. Bennit. Dated April 5th.

8,140. "Improvements in switches for electric circuits." G. Wright. Dated April 5th. (Date applied for under Patents, &c., Act, 1883, Section 103, September 18th, 1897, being date of application in United States.)

8,142. "Improvements in systems of electrical distribution." B. G. Lamme. Dated April 5th. (Date applied for under Patents, &c., Act, 1883, Section 103, September 18th, 1897, being date of application in United States.)

8,149. "Improvements in electric welding machines." C. Nielson. Dated April 5th.

8,179. "Improvements in and connected with means for electrically lighting railway carriages." E. Dick. Dated April 6th.

8,192. "Improvements in electrical connections, switches, and terminals." R. F. Hall. Dated April 6th.

8,202. "Apparatus for quickly and tightly closing, and quickly opening portable electric batteries." S. F. Walker. Dated April 6th.

8,222. "Improvements in clutches and brakes for arc electric lamps." G. Bing and A. E. Angold. Dated April 6th.

8,233. "Improvements relating to electric tram and like cars." J. T. Himmeger and J. Crowley. Dated April 6th.

8,262. "An improved controlling device for electric motor vehicles and the like." G. H. Rayner. (H. Leitner, France.) Dated April 6th.

8,273. "Improvements in and connected with electric bells." H. Oppenheimer. Dated April 7th.

8,274. "Improvements in and connected with electric bells." H. Oppenheimer. Dated April 7th.

8,275. "Improvements in and connected with annunciator movements." H. Oppenheimer. (Actien-Gesellschaft Mix & Genest, Germany.) Dated April 7th.

8,276. "Improvements in and connected with primary batteries." H. Oppenheimer. Dated April 7th.

8,277. "Improvements in and connected with keys or switches for multiple switchboards." H. Oppenheimer. (Actien-Gesellschaft Mix & Genest, Germany). Dated April 7th.

8,278. "Improved fuse box for electric light cables requiring resin, oil, or other compounds as an insulating material at terminal joints, &c." D. S. Strang. Dated April 7th.

8,298. "Electro-photo-telegraph." A. Bein and J. Breuer. Dated April 7th.

8,301. "Improvements in the construction of Morse's registering telegraphic instruments." E. Ducretet. Dated April 7th. (*Complete.*)

8,314. "Improved electric pile." G. Rosset and J. Rosset. Dated April 7th.

8,319. "Improvements in electrodes, and in the method employed for producing them." K. Krebs. Dated April 7th.

8,328. "Improvements in or relating to electric arc lamps." A. Ross. Dated April 7th.

8,348. "Improvements in electrical measuring and indicating instruments." A. C. Heap. Dated April 7th.

8,371. "Improvements in electro-magnets." M. Bouchet. Dated April 7th.

8,374. "Improvements in arc lamps." G. C. Fricker. Dated April 7th.

8,391. "Improvements in high-tension transformers and induction coils for Röntgen ray work, and for other purposes." A. L. Davis. Dated April 9th.

8,393. "Improvements in electric arc lamps." H. V. James. Dated April 9th.

8,398. "Improvements in electric motors." P. S. Swan. Dated April 9th.

8,441. "Electric recording system." C. L. Jaeger. Dated April 9th. (*Complete.*)

8,442. "Improvements in electric meters, cores, and circuit controllers." W. D. Marks. Dated April 9th. (Date applied for under Patents, &c, Act 1883, Sec. 103, September 10th, 1897, being date of application in United States) (*Complete.*)

8,477. "Improved electric accumulators." B. A. Bouvier and G. L. Augieras. Dated April 9th.

* Dynamos have been designed (Prof. Ryan) on the lines of a continuous current transformer with the second or neutralising coils wound in slots in the pole faces. As these slots were filled with copper they added considerably to the reluctance of the magnetic circuit, and it was therefore proposed to make the conductors of slabs of wrought-iron insulated from, but bolted to, the poles. The writer went into this with Mr. Mordey in 1893, but came to the conclusion that the cost of machining, insulating, and connecting up at the ends was too stiff a price to pay for the somewhat doubtful advantage of eliminating the lead of the brushes.